A Descriptive Catalogue of Indian Astronomical Instruments

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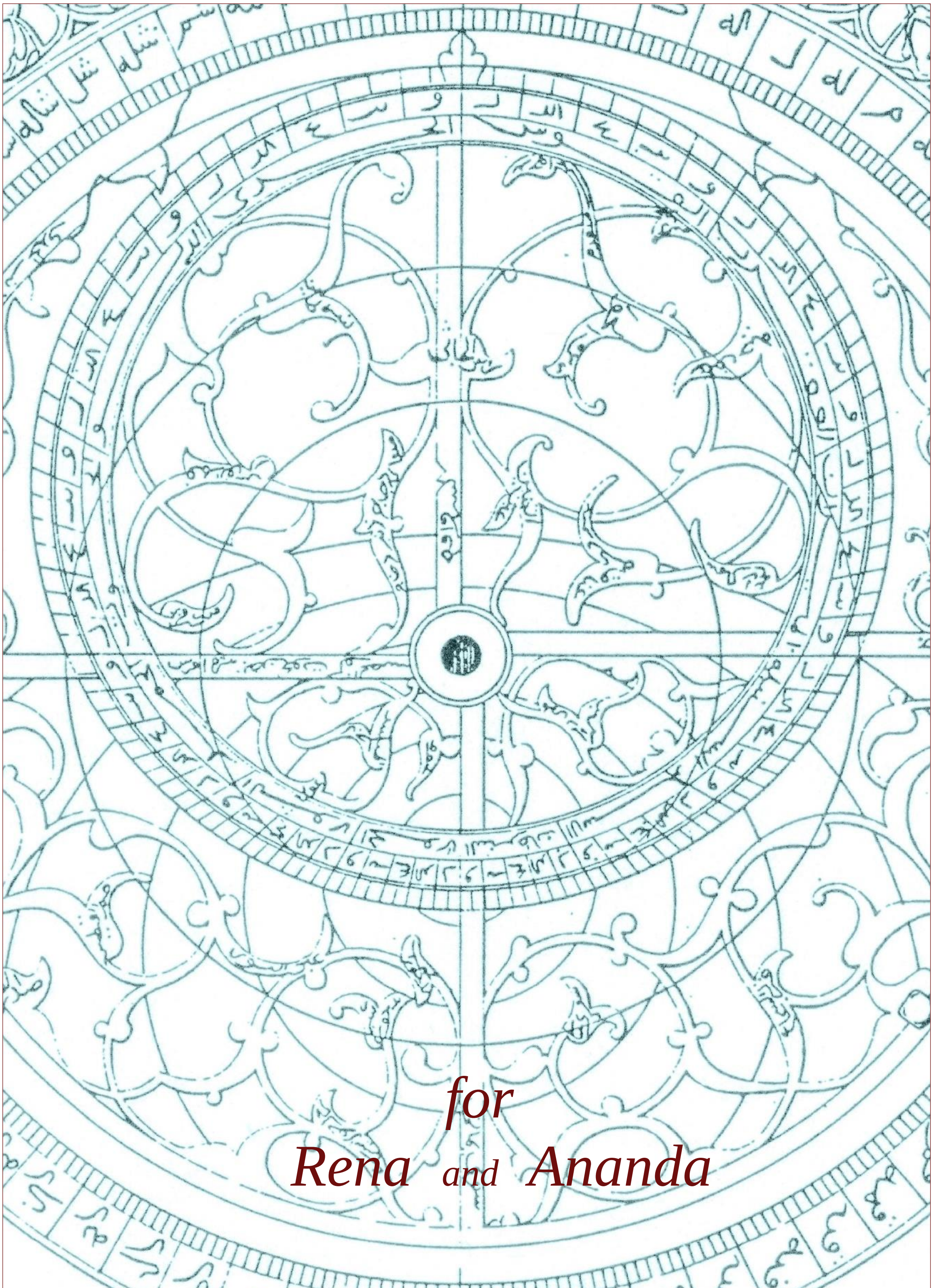

for

Rena and Ananda

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PREFACE

In AD 628, Brahmagupta completed his monumental *Brāhmasphuṭa-siddhānta* which, as David Pingree observes, 'was enormously influential on later Indian astronomy as well as on Islamic and Western European' astronomies.[i] The twenty-second chapter of this work describes the construction and use of several astronomical instruments, from the simple quadrant to mercury-driven perpetual motion machines. While studying this chapter,[ii] I wondered whether any specimens of these instruments are preserved today in museums. Such specimens, I thought, would help in understanding better the rather brief descriptions in Sanskrit texts. Therefore, a survey of Sanskrit astronomical instruments in various museums in India would a worthwhile task, I reflected. But gradually I came to realise that many Sanskrit instruments are closely related to Islamic astronomical instruments, that several Islamic astronomical instruments were also produced in India as well and that large numbers of specimens of Sanskrit as well as Islamic astronomical instruments are preserved in museums abroad, especially in UK.

It is about this time that I came across a catalogue of the exhibition on 'Science in India' which was mounted by the Science Museum of London in connection with the Festival of India in 1982. The exhibition gave an admirable account of scientific activity in India from the earliest times up to the present day, by means of manuscripts and artefacts. The catalogue, compiled by Dr R. G. W. Anderson, who later became the Director of the British Museum, made me aware of the actual specimens of Indian astronomical instruments which are still extant in various museums in India and abroad. Encouraged by this catalogue and later by personal conversations with Dr Anderson and other scholars, I began studying Indian astronomical instruments in museums and private collections within India and outside.

Thus began my exploration of pre-modern Indian astronomical instruments in 1991 which lasted a quarter century and spanned three continents.[iii] A descriptive catalogue of the extant instruments which I identified during the course my explorations in about a hundred museums and private collections is presented in the following pages. The majority of the surviving instruments are astrolabes. These are not simple measuring tools. Their fabrication from sheets of brass demands sophisticated workmanship. Engraving the various kinds of lines and circles on the plates and on the back requires high precision. Fashioning the *kursī* and the rete involves fine artistic sense. Furthermore, large quantities of astronomical, astrological and geographical data

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i Pingree 1981, p. 21.

ii Sarma 1986-87a

iii I tried to cover all the known collections in India, Europe and USA; in India, the Asiatic Society, Kolkata, Indian Museum, Kolkata, and L. D. Institute, Ahmedabad, are known to own astronomical instruments, but they did not respond to my repeated requests for permission to study the instruments in their collections. New museums are coming up in Kuwait and in the United Arab Emirates, some of which are reported to possess Indo-Persian astrolabes and celestial globes, but I have not been able to contact these museums.

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are engraved on them. Therefore, astrolabes have been carefully preserved by owners and eagerly collected by cognoscenti throughout the centuries in all the regions.

In this catalogue, astrolabes are described in five sections A, B, C, D and E. Then follow celestial globes in three sections F, G and H. These are also products of excellent metal craft and artistic beauty. Thereafter are treated diverse kinds of instruments which exist in smaller numbers.

I have personally examined and photographed many of the instruments described in this catalogue. In some cases, where I could not personally study the instruments, detailed information and photos were kindly sent to me by museums, auction houses and private collectors. The third source is archival. At the Museum of the History of Science, Oxford, Francis Maddison collected a large number of photos of astrolabes and of other instruments which were sent to him for evaluation by auction houses. Likewise, Anthony J. Turner, Le Mesnil-le-Roi, has a large collection of photos. Both very generously lent me photos of Indian instruments in their collections. These photos fill important gaps and help in a drawing a more comprehensive picture of instrument production in India.

Astronomical instruments produced in India in the pre-modern period can be classified into two broad groups. In the first group are those with inscriptions and legends in Arabic and Persian. More specifically, the astronomical technical terms are in Arabic, and the inscriptions regarding the manufacture or ownership are often in Persian. These are classified as Indo-Persian instruments, because they were produced in a milieu where Persian was the official or scholarly language. The second group consists of instruments on which the legends are in Sanskrit language and in Devanagari script. These are called Sanskrit instruments. The original prototypes for the Indo-Persian instruments were derived from the Islamic world. Some of the Sanskrit instruments are indigenous to the Indian subcontinent and some others are adapted from Islamic models. There is also a small number of Sanskrit instruments derived from European models.

Excluded from this survey are the modern or post-telescopic astronomical instruments which were directly imported from the west and did not undergo any substantial variation in India, even when they were manufactured here. A further distinction between these two groups of pre-modern and modern instruments lies in the manner and scale of production: the former were produced by traditional artisans and each item was a unique product, whereas the latter were industrial products on a mass scale with identical copies. This difference is somewhat akin to the difference between manuscripts and printed books.

This does not mean that modern instruments like telescopes, sextants, transit circles have no historical value. Just as the copies of the first edition of a book are valuable as collectibles, so are also nineteenth century European instruments of historical interest. Universities and other academic institutions in India still possess many such historically interesting European instruments. These also deserve to be catalogued; in fact, even other kinds of scientific instruments and obsolete measuring

devices like steel-yards which are scattered in museum stores need to be studied; but it is beyond the scope the present catalogue.[iv]

Had I known the enormity of the project, I probably would not have ventured in the first place. But the interest and encouragement shown by scholars and the enthusiastic cooperation of museum directors gave me the necessary confidence to continue with the project. Therefore, the list of persons to whom I owe deep debt gratitude is rather long.

I am quite conscious of the many shortcomings in this catalogue, caused by my linguistic and technical limitations. But I do hope that this first ever attempt at compiling the information about pre-modern Indian astronomical instruments which are dispersed in many parts of the world will be of some use to the historians of science and to the curators of museums.

[iv] National inventories of scientific instruments, both pre-modern and modern, are being compiled elsewhere. In the 1950s, the History of Science Division of the International Union for History and Philosophy of Science set up a commission to promote the compilation of an 'inventaire mondiale des appareils scientifiques historiques'. The first step in this direction was to compile national inventories. Accordingly, several European countries brought out national inventories of scientific instruments: Belgium (1959-1960), Italy (1963), France (1964), USSR (1968), Czechoslovakia (1970; unpublished), Ireland (1990). The last and the most comprehensive in this series is *Science Preserved: A Directory of Scientific Instruments in Collections in the United Kingdom and Eire*, compiled by Mary Holbrook, R. G. W. Anderson & D. J. Bryden, London 1992.

ABBREVIATIONS AND OTHER CONVENTIONS

1. Abbreviations

anon = anonymous

attr = attributable

ca = circa

d = diameter

ed = edited

h = height

L = terrestrial longitude

mm = millimeters

nd = not dated

PC = private collection

PLU = present location unknown

r = reign

s.v. = sub voce

t = thickness

tr = translated

φ = terrestrial latitude

⊙ = instruments which I have personally examined

; = (semi-colon) mark of separation in sexagesimal system between degrees and minutes of arc and between hours and minutes of time

All linear measurements are in millimeters

Material of almost all instruments is brass; in a few cases, it is wood or wood and ivory. Only such cases will be mentioned in the catalogue. Where no material is mentioned, it should be understood as brass.

2. Other Abbreviations and Expressions

CCA = Sharon L. Gibbs, Janice A. Henderson & Derek de Sola Price, *A Computerized Checklist of Astrolabes*, Yale University, New Haven 1973 Astrolabes are identified with the serial numbers given here.

CESS = David Pingree, *Census of Exact Sciences in Sanskrit,* Series A, vols. 1-5, Philadelphia 1970-1994.

DSB = Charles Couston Gillipse*Dictionary of Scientific Biography,* 16 vols, 1970-1980.

ESS = Emilie Savage-Smith, *Islamicate Celestial Globes: Their History, Construction and Use*, Washington, D.C., 1985. ESS followed by a serial

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number refers to the globe under this serial number in the catalogue part of the book.

Khalili = Nasser D. Khalili Collection of Islamic Art, London

MHS = Museum of the History of Science, Oxford

NMM = National Maritime Museum, Greenwich

Répertoire = Alain Brieux, Francis Maddison, avec la collaboration de Ludwik Kulus et Yusuf Ragheb, *Répertoire des Facteurs d'Astrolabes, et leurs oeuvres. Islam, plus Byzance, Arménie, Géorgie et Inde Hindoue* (in press). I use the 1993 version. Here the instrument makers are listed alphabetically and under each name the instruments by this maker are listed chronologically with serial numbers. Répertoire, followed by a serial number, refers to an instrument made by the instrument maker concerned.

India, Indian = refer to the Indian subcontinent

Indo-Persian = refers to artefacts produced in India where Persian was the official and/or academic language

Islam, Islamic= refer to the culture of the Islamic world and not to the religion.

3. Chronology

AD = Anno Domini, Christian era

AH/H = Hijrī era (lunar)

Śaka = Śaka era (luni-solar)

VS = Vikrama Saṃvat (luni-solar)

Dates in Hijrī era are converted by the CALH (Calendar conversion program) developed by Benno van Dalen.
http://www.bennovandalen.de/Programs/programs.html
[also http://goo.gl/gFvLXO, last accessed in May 2016]

Dates in Śaka and Vikrama Saṃvat eras are converted by the 'Pancanga' program developed by Michio Yano and Makoto Fushimi
http://www.cc.kyoto-su.ac.jp/~yanom/pancanga/index.html
[also http://goo.gl/MN37FC, last accessed in May 2016]

4. Languages

The language of the engravings on the Indo-Persian instruments is mainly Persian with Arabic technical terms. The transcription of these Arabic terms is somewhat peculiar. Because of the limited space available for engraving, or even otherwise, the Arabic definite article *al-* is often omitted. Epithets in masculine gender are added to nouns even when the latter are feminine. The term *ra's* (head) is generally transcribed as *rās*. In order to retain the peculiarity of the language, the engravings are transliterated exactly, without making any attempt at assimilation or vocalization either according to the usage either in Arabic or in Persian.

As will be explained in the introduction to Sanskrit astrolabes, unlike in the Islamic and in Indo-Persian milieu in India, no professional class of Sanskrit instrument makers

developed. Hindu or Jaina astronomers or astrologers, who used Sanskrit as the language of learning, when they wished to have instrument, themselves prepared the technical designs and the text of engravings and asked the willing brass worker, who may be barely literate, to prepare the instrument. Consequently, the Sanskrit engravings of star names and even place names are often incorrect. Therefore, I have added the correct version in most of the cases, for the sake of intelligibility.

5. Transliteration

Arabic/ Persian

ص	ش	س	ز	ر	ذ	د	خ	ح	ج	ث	ت	ب	آ	ا
ṣ	*sh*	*s*	*z*	*r*	d	*d*	*kh*	*ḥ*	*j*	*th*	*t*	*b*	*ā*	*a*
ء	ی	ه	و	ن	م	ل	ک	ق	ف	غ	ع	ظ	ط	ض
ʻ	*y/ī*	*h*	*w/au*	*n*	*m*	*l*	*k*	*q*	*f*	*gh*	c	*ẓ*	*ṭ*	*ḍ*

Transliteration Sanskrit

अ	आ	इ	ई	उ	ऊ	ऋ	ए	ऐ	ओ	औ	◌ं	◌ः		
a	*ā*	*i*	*ī*	*u*	*ū*	*ṛ*	*e*	*ai*	*o*	*au*	*ṃ*	*ḥ*		
क	ख	ग	घ	ङ	च	छ	ज	झ	ञ	ट	ठ	ड	ढ	ण
k	*kh*	*g*	*gh*	*ṅ*	*c*	*ch*	*j*	*jh*	*ñ*	*ṭ*	*ṭh*	*ḍ*	*ḍh*	*ṇ*
प	फ	ब	भ	म	य	र	ल	व	श	ष	स	ह		
p	*ph*	*b*	*bh*	*m*	*y*	*r*	*l*	*v*	*ś*	*ṣ*	*s*	*h*		

6. Numerical Notations

Abjad | On Indo-Persian instruments, the numerical quantities are transcribed mostly in the *Abjad* alpha-numeric notation and occasionally with the common Arabic/Persian numerals. Khareghat published a very convenient table of the *Abjad* notation which is reproduced below. [v]

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[v] From Khareghat 1950, pp. x-xii. In the argument astrolabe is misspelt.

Number	Value in Letters	How engraved on the Astralobe	Number	Value in Letters	How engraved on the Astralobe	Number	Value in Letters	How edgraved on the Astralobe
1	ا	ا	21	کا	کا	41	ما	ما
2	ب	ٮ	22	کب	کٮ	42	مب	مٮ
3	ج	ح	23	کج	کح	43	مج	مح
4	د	د	24	کد	کد	44	مد	مد
5	ه	ه	25	که	که	45	مه	مه
6	و	و	26	کو	کو	46	مو	مو
7	ز	ر	27	کز	کر	47	مز	مر
8	ح	ح	28	کح	کح	48	مح	مح
9	ط	ط	29	کط	کط	49	مط	مط
10	ی	ے	30	ل	ل	50	ن	ٮه
11	یا	ىا	31	لا	لا	51	نا	ٮا
12	یب	ٮ	32	لب	لٮ	52	نب	ٮ
13	یج	ىح	33	لج	لح	53	نج	ٮح
14	ید	ىد	34	لد	لد	54	ند	ٮد
15	یه	ىه	35	له	له	55	نه	ٮه
16	یو	ىو	36	لو	لو	56	نو	ٮو
17	یز	ىر	37	لز	لر	57	نز	ٮر
18	یح	ىح	38	لح	لح	58	نح	ٮح
19	یط	ىط	39	لط	لط	59	نط	ٮط
20	ک	ک	40	م	م مه	60	س	سه

Number	Value in Letters	How engraved on the Astralobe	Nnmber	Value in Letters	How engraved on the Astralobe	Number	Value in Letters	How engraved on the Astralobe
61	سا	سا	82	فب	ڡٮ	155	قنه	قنه
62	سب	سٮ	83	فج	ڡح	160	قس	قسم
63	سج	سح	84	فد	ڡد	165	قسه	قسه
64	سد	سد	85	فه	ڡه	170	قع	قع
65	سه	سه	86	فو	ڡو	175	قعه	قعه
66	سو	سو	87	فز	ڡر	180	قف	قڡ
67	سز	سر	88	فح	ڡح	185	قفه	قڡه
68	سح	سح	89	فط	ڡط	190	قص	قصم
69	سط	سط	90	ص	صم	195	قصه	قصه
70	ع	ع	95	صه	صه	200	ر	ر
71	عا	عا	100	ق	ق	205	ره	ره
72	عب	عٮ	105	قه	قه	210	رے	رے
73	عج	عح	110	قے قی	قے	215	ريه	ريه
74	عد	عد	115	قيه	قيه	220	رک	رکـ
75	عه	عه	120	قک	قکـ	225	رکه	رکه
76	عو	عو	125	قکه	قکه	230	رل	رل
77	عز	عر	130	قل	قل	235	رله	رله
78	عح	عح	135	قله	قله	240	رم	رمم
79	عط	عط	140	قم	قم	245	رمه	رمه
80	ف	ڡ	145	قمه	قمه	250	رن	رنم
81	فا	ڡا	150	قن	قن	255	رنه	رنه

Number	Value in Letters	How engraved on the Astralobe	Number	Value in Letters	How engraved on the Astralobe	Number	Value in Letters
260	رس	رسم	310	شي	شي	360	شس
265	رسه	رسه	315	شبه	شبه	400	ت
270	رع	رعم	320	شک	شک	500	ث
275	رعه	رعه	325	شکه	شکه	600	خ
280	رف	رف	330	شل	شلم	700	ذ
285	رفه	رفه	335	شله	شله	800	ض
290	رص	رصم	340	شم	شمم	900	ظ
295	رصه	رصه	345	شمه	شمم	1000	غ
300	ش	شم	350	شن	شنم	0	ها
305	شه	شه	355	شنه	شنه		

Common Arabic/ Persian Numerals | used occasionally on Indo-Persian instruments
١ (1), ٢ (2), ٣ (3), ۴ (4), ۵ (5), ۶(6), ٧ (7), ٨ (8), ٩ (9), ٠ (0).

Devanagari Numerals | used generally on Sanskrit instruments
१ (1), २ (2), ३ (3), ४ (4), ५ (5), ६ (6), ७ (7), ८ (8), ९ (9), ० (0).

The Sanskrit alpha-numeric system called ***Kaṭapayādi*** is employed in a few Sanskrit instruments, in imitation of the *abjad* notation on Indo-Persian instruments.[vi]

1	2	3	4	5	6	7	8	9	0
क *ka*	ख *kha*	ग *ga*	घ *gha*	ङ *ṅa*	च *ca*	छ *cha*	ज *ja*	झ *jha*	ञ *ña*
ट *ṭa*	ठ *ṭha*	ड *ḍa*	ढ *ḍha*	ण *ṇa*	त *ta*	थ *tha*	द *da*	ध *dha*	न *na*
प *pa*	फ *pha*	ब *ba*	भ *bha*	म *ma*					
य *ya*	र *ra*	ल *la*	व *va*	श *śa*	ष *ṣa*	स *sa*	ह *ha*		unattached vowels

Bhūtasaṃkhyā | A more widely employed notation, in Sanskrit texts on astronomy and mathematics, and also in inscriptions, is generally known as the *Bhūtasaṃkhyā* system, or 'word numerals', where Sanskrit words denoting the sky stand for zero, words denoting the moon etc., represent one, words denoting objects that occur in pairs, like eyes, ears, hands etc., express 'two' and so on.[vii] But this notation is not used on any instrument.

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vi Sarma 1999b; Sarma 2012d.

vii Bīrūnī 1910; SarmaKV 2003; Sarma 2009b.

ACKNOWLEDGEMENTS

In Indian Academic tradition, it is customary to commence with a homage to one's gurus. From Prof. David A. King (University of Frankfurt) I received my first lessons in how to study an astrolabe when I accompanied him to the Salar Jung Museum at Hyderabad and to the Jaipur Observatory in 1991. In his monumental *In Synchrony with the Heavens*, he dedicated a section to me and mentioned there my work with approval. I cannot think of any honour higher than this.

The little knowledge I acquired in these years on the medieval astronomical instruments is due to the writings of the late Prof. Willy Hartner (University of Frankfurt), Prof. David A. King (University of Frankfurt), the late Francis Maddison (Museum of the History of Science, Oxford), James Morrison (Rehoboth Beach, Delaware, USA), the late Prof. David Pingree (Brown University, Providence), Prof. Emilie Savage-Smith (University of Oxford) and Anthony J. Turner (Le Mesnil-le-Roi, France). Not only their books, but they themselves helped me in myriad ways through all these years. To these gurus, I address my first acknowledgement of gratitude.

I owe a deep debt of gratitude to Prof. Fuat Sezgin, the founder and director of the Institut für die Geschichte der Arabisch-Islamischen Wissenschaften at Frankfurt. I had the privilege of using the rich library and the guest apartment of the Institute several times. Prof. Sezgin established a unique museum of history of science and technology in Islam with replicas of instruments and artefacts which were carefully reconstructed from descriptions and diagrams in Arabic manuscripts, and prepared a large comprehensive catalogue of this museum in five volumes. He entrusted my wife and me the task of translating this catalogue from German into English. Through this translation I could widen my knowledge of the Islamic astronomical instruments.

At Aligarh Muslim University, where I spent most of my professional career, my stay was considerably enriched by the occasional conversations with Prof. Irfan Habib who always found time to answer my queries on medieval Indian history and has translated several Persian passages for me, for which I am highly obliged.

Special thanks are due to Prof. Owen Gingerich (Harvard University), the only university professor I know who owns an Indo-Persian astrolabe, for his encouragement and help at the initial stages of my work.

It is my pleasant duty to thank two friends and colleagues of long standing for their encouragement and constant support. Professor S. M. Razaullah Ansari (formerly Professor of Physics at Aligarh Muslim University and formerly President of the Commission for the History of Ancient and Medieval Astronomy) aroused my interest in astronomical instruments by suggesting that I prepare an edition and translation the *Yantraprakāra* which the astronomer prince Sawai Jai Singh got compiled before he designed the huge instruments in masonry.[viii] He also has published some of my early

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viii Sarma 1986-87a.

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studies on instruments in the *Studies in History of Medicine and Science* of which he was the editor. Dr A. K. Bag (History of Science Division, Indian National Science Academy, New Delhi) has been very supportive of my project from the beginning. He published several of my papers in the *Indian Journal of History of Science* and thus gave me the opportunity to present my work to a wider academic community.

Three other friends whose expertise in Sanskrit and Arabic sources on astronomy and mathematics I could always draw on are Professors Michio Yano (Kyoto Sangyo University), Takao Hayashi (Doshisha University, Kyoto) and Takanori Kusuba (Osaka University of Economics). Prof. Hayashi read parts of this catalogue and made valuable suggestions for improvement. It is a pleasure to express my thanks to them.

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For this project, I received funding from the following sources, which is gratefully acknowledged. The Scientific Instrument Commission (Dr R. G. W. Anderson, President; Prof. G L' E. Turner, Secretary) awarded me a grant for studying Indian astronomical instruments in the museums in UK in summer 1993.

Through the initiative of Prof. Nalini Balbir (Sorbonne Nouvelle, University of Paris 3), I was offered Visiting Professorship at her department to study Indian instruments in Paris from mid-September to mid-October 1994.

On the recommendation of Prof. David A. King (Institute für Geschichte der Naturwissenschaften, Goethe University, Frankfurt), the Deutsche Akademische Austauschdienst awarded me a scholarship to study the Indian instruments in Germany in the winter 1995-96.

Through the initiative of Dr A. K. Bag, the Indian National Science Academy, New Delhi, awarded me a project to study the instruments in the various museums in India from October 1998- September 2001.

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Now I must record my deep appreciation and grateful thanks to the authorities of all the museums for opening the treasures of their collections for my study.

Museums in India

I began my exploration of museums in May 1991 at the **Salar Jung Museum, Hyderabad**, where I had my first glimpse of the astrolabes and globes of the Lahore Family, with the warm-hearted cooperation of the director Dr M. L. Nigam and the keeper of the manuscripts Dr Rahmat Ali Khan. The next director Dr I. K. Sarma invited me to deliver the Salar Jung Memorial Lecture in 1995 and published the lecture under the title *Astronomical Instruments in the Salar Jung Museum*.[ix] During my third visit in 2004, the director Dr A. K. V. S. Reddy treated me as a special guest of the museum.

[ix] Sarma 1996a.

There are two other places in India which I visited frequently for the project. Sawai Jai Singh, aside from erecting huge astronomical instruments in masonry, collected some splendid masterpieces of Lahore astrolabes. His son Sawai Madho Singh designed some interesting instruments. A veritable treasury of these and several other instruments are preserved at the **Jaipur Observatory**. I went several times to Jaipur to study these instruments. I would like to thank the authorities of the Rajasthan State Department of Archaeology and Museums and, in particular, the Superintendent of the Observatory, Pandit Om Prakash Sharma. Pandit Om Prakash Sharma constructed a special gallery to display these portable instruments.

The **Rampur Raza Library** owns important instruments which I studied with the warm support of the late Dr W. H. Siddiqi, officer on special duty. Akbar Ali Khan Arshizada and Abu Sad Ilahi deciphered and translated Arabic and Persian inscriptions on some of these instruments. Dr Siddiqi desired that I prepare a catalogue of the astronomical instruments in their collection with the photographs by Mirza Jamshed Agha; the catalogue was published quite elegantly by Tanzim Raza Qureshi, Islamic Wonders Bureau, Delhi.

The other museums I visited in India are listed in alphabetical order of the cities, with the names of the authorities in parentheses.

Aligarh, Aligarh Muslim University, **Ajmal Khan Tibbia College** (principal).

Hyderabad: **Saidia Library** (Ahmad Athaullah); **State Museum of Archaeology** (S. S. Rangacharylu, assistant director).

Jaipur: **Government Sanskrit College** (Prof. Vijay Kumar Sharma); **Museum of Indology** (Ramachandra Vyakul); **Sanjay Sharma Memorial Museum** (Ram Kripalu Sharma and Tilak Raj Sharma).

Lucknow: **Nadwatul Ulama** (M. Haroon Nadwi, librarian of the Shibli Nomani Library),

Mumbai, **Chatrapati Shivaji Sangrahalay** (Dr Kalpana Desai, director; Arvind Fondekar, assistant curator); **K. R. Cama Oriental Institute** (Homai N. Modi, trustee).

New Delhi: **Archaeological Museum**, Red Fort (Director-General of the Archaeological Survey of India); **National Museum** (U. Das, keeper; Anamika Pathak, C.A.).

Patna: **Khuda Bakhsh Oriental Public Library** (Dr A. R. Bedar, director; Md. Atiqur Rehman, assistant librarian; Ata Khurshid, library assistant; Dr Mohammad Zakir Hussain, research scholar).

Srinagar: University of Kashmir**, Central Asian Museum** (Nazir Ahmad Doshab, photographer).

Vadodara: MS University of Baroda, **Oriental Institute** (Prof. M. L. Wadekar, director; Dr. Sweta Prajapati); **Sanskrit Mahavidylaya** (Prof. Yogesh B. Oza, principal).

Varanasi: Banaras Hindu University, **Bharat Kala Bhavan** (Dr R. C. Sharma, director; Yashodhara Agarwal, curator); Sampurnanand Sanskrit University, **Sarasvati Bhavan Library** (Prof. Mandan Mishra, vice-chancellor; D. S. Mishra, assistant librarian).

MUSEUMS IN UK

In 1989, I attended the International Congress of History of Science at Hamburg and made a presentation on the 'Astronomical Instruments in Mughal Miniatures.'[x] In the course of my presentation, I spoke about the need of an inventory of the extant astronomical instruments produced in India. The audience included Dr R. G. W. Anderson and Prof. G. L' E. Turner, who were then the president and secretary of the Scientific Instrument Commission. They approved of my idea and suggested that I should begin the work in UK where there are large collections. But I could not make it to UK until the summer of 1993.

A large part of my stay was spent at the **Museum of the History of Science at Oxford**, where the director Francis Maddison showed keen interest in my work. He allowed me access to a large collection of photographs of astronomical instruments which various auction houses sent him for his evaluation. He also allowed me to copy the relevant parts of the *Repertoire* he was then compiling. This work was never published, but the 1993 version I have has been very valuable for my work. I am highly indebted to him and also to Dr W. D. Hackmann, assistant director; A. V. Simcock, librarian and L. Norman, photographer. I was again in this museum in 2005 and the new director Dr Jim Bennett very kindly provided me all facilities to study the instruments. The present director, Dr Silke Ackermann, graciously permitted me to include several museum photos in this catalogue.

The other museums I visited in UK are listed in alphabetical order of the cities.

Cambridge: **Whipple Museum of the History of Science** (Dr J. A. Bennett, curator).

Cardiff: **Welsh Industrial and Maritime Museum** (Alex Dawson, documentation officer).

Edinburgh: **Royal Museum of Scotland** (Dr Alison Morrison-Low provided me excellent photos of instruments in the museum).

London: **British Museum** (Dr R. G. W. Anderson, director; Dr Richard Blurton; and Beatriz Waters); **The Clockmakers' Company Collection,** Guildhall (Sir George White, curator); **Horniman Museum** (Ken Teague, assistant keeper); **Nasser D. Khalili Collection of Islamic Art** (Prof. Nasser D. Khalili and Nahla Nassar, registrar); **National Maritime Museum,** Greenwich (Dr Kristin Lippincott, Dr Gloria Clifton, Dr Louise Devoy); **Science Museum** (Kevin Johnson, Alison Boyle); **Victoria and Albert Museum** (Anthony North, Susan Strange).

Oxford: **Pitt Rivers Museum of Ethnology** (Linda Mowat, assistant curator).

MUSEUMS IN USA

Prof. David Pingree offered me visiting associate professorship at his Department of History of Mathematics at Brown University Providence for the year 1992-93. This

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[x] Sarma 1992a.

gave me the opportunity to visit the various museums in the USA with collections of Indian astronomical instruments. More important, I read Mahendra Sūri's *Yantrarāja,* the first Sanskrit manual on the astrolabe, with David Pingree and his students. I also had the opportunity to read the catalogue of Sanskrit and Indo-Persian astrolabes in the Adler Planetarium at Chicago, which Pingree was then preparing and which appeared posthumously in 2009 under the title *Eastern Astrolabes.*

Chicago: The **Adler Planetarium and Astronomy Museum** (Roderick Webster and Marjorie Webster, honorary curators). I am highly thankful to Dr Pedro Raposo, the present director, and Lauren Boegen, digital collections manager, for their kindness in generously sending me more than a hundred digital images of the Indian instruments in their collection.

New Haven, Yale University, **Cushing/Whitney Medical Library** (Dr Melisa Graffe, librarian).

New York: Columbia University, **Butler Library, Rare Book and Manuscript Library** (Rudolph Ellenbogen, assistant librarian).

Rockford: **Time Museum** (Patricia H. Atwood, executive director).

Washington, D. C.: **National Museum of American History** (Dr Peggy Kidwell and (late) Silvio Bedini).

I must offer special thanks to Dr David Coffeen (**Tesseract**, Hastings-on-Hudson, NY) for many photos of instruments in his collection anf for valuable suggestions.

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Paris: **Institute du Monde Arabe** (Jeanne Mouliérac); **Observatory of Paris** (Dr Jean-Pierre Verdet, Dr Suzanne Débarbat.

Anthony Turner and Dominique Brieux helped me in studying the instruments in private collections.

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With a scholarship from the Deutsche Akademische Austauschdienst, I spent the winter 1995-96 at Prof. David King's Institut für die Geschichte der Naturwissenschaften, where I could make use of the rich library of the Institute and benefit from the expertise of Prof. King's students, Dr Francoise Charette, Dr Benno van Dalen, Dr Petra Schmidl and Dr Burkhard Stautz.

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Other museums I visited in Germany are Kunstgewerbesammlung der Stadt Bielefeld, Linden Museum, Stuttgart, and Kestner Museum, Hannover.

BELGIUM

In Belgium, there are several Indian instruments in private collections and it is to the credit of Jan De Greave that I could study and photograph these instruments.

NETHERLANDS

Leiden, **Museum Boerhaave** (Tiemen Cocquyt).

PAKISTAN

I did not have the opportunity to visit the museums in Pakistan. Dr Nasim Naqvi (London) obtained for me some photographs of instruments through his contacts. Now Mubashir Ul-Haq Abbasi (Institute of Space Technology, Islamabad, Pakistan) kindly sent me photos and information of instruments in the **Islamabad Museum**, **Lahore Museum** and **National Museum of Pakistan** at Karachi. He is also preparing a comprehensive catalogue of the astronomical instruments preserved in the museums of Pakistan.

TURKEY

I did not have the chance to visit Istanbul. At **Kandilli Observatory and Earthquake Research Institute**, Prof. Mustafa Aktar, professor of geophysics and in-charge of the collection of historical instruments, very kindly sent me photos and the exact measurements of the Indian instruments in the collection.

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Besides the museums mentioned above, many private collectors allowed me to study the Indian instruments in their collections; some have provided me with good photos. I am much obliged to them, but it is not appropriate to identify them with their names.

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Outside the museums, I am highly obliged to many scholars for arranging my lectures on instruments, for publishing my papers, for introducing me to the museums and private collectors and various other kinds of help.

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Egypt: Dr Flora Vafea (Cairo); Ayman Aly (Cairo).

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Iran: Prof. Mohammad Bagheri (Institute for the History of Science, University of Tehran).

Italy: Dr Paulo Brenni (President, Scientific Instruments Society); Dr Ileana Chinnici (Palermo Observatory, Palermo, Italy); Prof. Mara Miniati (Curator Emeritus, Museo Galileo, Florence).

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Sweden: Dr Martin Gansten (Lund, Sweden).

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Thailand: Prof. Ampha Otrakul (Chulalongkorn University, Bangkok).

UK: Dr Josefina Rodriguez Arribas (Warburg Institute, University of London); Prof. Charles Burnett (Director, Warburg Institute, University of London); Jeremy Collins (Christie's, London); Dr Roy Fischel (School of Oriental and African Studies, University of London); Dr Edward Gibbs (Sotheby's, London); Dr Willem Hackmann (Editor, *Bulletin of the Scientific Instruments Society*).

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For their abiding friendship and many acts of I help, I owe a special debt of gratitude to Ursula and Oskar Kober (Homberg/Efze, Germany).

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PREAMBLE

तनुर्नेत्रैर्न्यूना नृपतिरहिता राजनगरी
सरस्यो निष्पद्मा युवतिरपि कान्तेन रहिता |
निशा निःशीतांशुः सरिदपि यथा चक्ररहिता
तथा ज्योतिर्विद्या भवति विफला यन्त्ररहिता ||

tanur netrair nyūnā nṛpatirahitā rājanagarī
sarasyo niṣpadmā yuvatir api kāntena rahitā |
niśā niḥśītāṃśuḥ sarid api yathā cakrarahitā
tathā jyotirvidyā bhavati viphalā yantrarahitā ||

Like body without eyes, royal capital minus the king,
lakes devoid of lotus flowers, a young woman without a lover,
the night without the moon, a river bereft of *Cakravāka* birds,
even so astronomical science is fruitless without instruments.

— Rāmacandra Vājapeyin, 1428, *Yantra-prakāśa*

In reconstructing the history of science and technology of any civilization, scientific instruments play as valuable a role as literary documents do. This is particularly true of astronomical instruments. As Francis Maddison, long-time curator of the famous Museum of the History of Science at Oxford, remarks:

> It was in astronomy that accurate measurement was first used systematically to obtain quantitative evaluations of observed phenomena. The instruments which were invented and which developed in response to this approach to scientific enquiry are (…) worthy of study as primary sources of the history of scientific thought and of technological achievement.[11]

In the Indian subcontinent, scientific instruments were used throughout history. The large number of weights, the remains of some metal scales and the fragment of a linear scale incised on a shell, which were recovered at the Indus Valley sites of Mahenjo-daro and Harappa, are some of the earliest specimens of Indian scientific instruments.[12] Unfortunately, neither a systematic inventory of these instruments was made, nor were they studied in the context of their historical development. On the other extremity of the chronological scale, even Sawai Jai Singh's observatories, which must be ranked as unique astronomical monuments of the world, are in a sad state of neglect. The large masonry instruments which Jai Singh designed and erected in his observatories are indeed the culmination of a long process of development in astronomical instrumentation. But what sort of instruments were used until the eighteenth century, before the time of Jai Singh?

Sanskrit Texts on Astronomical Instruments

Sanskrit astronomical texts describe many instruments (*yantra*) for measuring time, for taking the altitudes of heavenly bodies, for measuring the angular distance between two celestial objects, for visually demonstrating the apparent motion of the heavens, and so on. Kauṭilya's *Artha-śāstra,* which was composed and expanded between the second century BC and the third century AD, speaks of measuring time by

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11 Maddison 1963, p. 17.

12 Bose, Sen & Subbarayappa 1971, pp. 137-138.

means of a water clock or with a gnomon.[13] At the beginning of the sixth century, Āryabhaṭa described several interesting astronomical instruments in his *Āryabhaṭa-siddhānta*. This work is now lost but the descriptions of the instruments survive in Rāmakṛṣṇa Ārādhya's commentary on the *Sūrya-siddhānta*.[14] About the middle of the sixth century, Varāhamihira discussed a few instruments in the fourteenth chapter of his *Pañca-siddhāntikā*.

The first systematic and comprehensive account of astronomical instruments (*kāla-yantras*) is provided by Brahmagupta in his *Brāhmasphuṭa-siddhānta,* which he completed in 628 in western India. Here the twenty-first chapter is devoted to the armillary sphere (*Gola-yantra*) and the twenty-second chapter to the other instruments. The armillary sphere is treated separately because it is primarily a didactic device and not a measuring tool. Moreover, it appears that students of astronomy were encouraged to assemble their own armillary spheres, because by arranging the various imaginary circles in the heavens such as the celestial equator, the ecliptic and others as physical entities in the armillary sphere, they can grasp the purpose and function of these imaginary circles. Therefore, *gola-bandha,* i.e., tying together the different rings to constitute the armillary sphere, seems to be part of the traditional curriculum.

In the twenty-second chapter called *Yantrādhyāya* (chapter on instruments), Brahmagupta describes the construction and use of nine varieties of instruments, *Dhanus, Turyagola, Cakra, Yaṣṭi, Śaṅku, Ghaṭikā, Kapāla, Kartarī* and *Pīṭha*. In addition, he describes eight types of accessories which are required when observations are made with instruments. He also describes some varieties of automata and perpetual motion machines (*Svayaṃvaha-yantra*).[15]

This procedure was adopted nearly in all the major astronomical texts in Sanskrit. In his *Śiṣyadhīvṛddhida-tantra,* Lalla (eighth or ninth century) devotes the fifteenth chapter *Golabandhādhikāra* for the construction of the armillary sphere and the twenty-

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13 Kauṭilya, *Arthaśāstra,* 1.19.6: *nālikābhir ahar aṣṭadhā rātriṃ ca vibhajet, chāyāpramāṇena vā.* '[The king] shall divide the day, and also the night, into eight parts, by means of the water clock or by means of the shadow-lengths [of the gnomon]. This passage will be discussed in detail in sections O (column dials) and R (water clocks).

14 These are retrieved and interpreted by Shukla 1967.

15 Sarma 1986-87a.

first chapter *Yantrādhyāya* for the following instruments: automata, *Gola, Cakra, Dhanus, Kartarī, Kapāla, Pīṭha, Bhagaṇa, Śaṅku, Ghaṭī, Śalākā, Śakaṭa* and *Yaṣṭi.* Of these *Bhagaṇa, Śalākā* and *Śakaṭa* are new; these have not been described by Brahmagupta.

In his *Siddhānta-śekhara* of 1039, Śrīpati discusses the instruments somewhat briefly as compared to Lalla. The construction of the armillary sphere is treated in the fifteenth chapter entitled *Golādhyāya*. The nineteenth chapter entitled *Yantrādhyāya* deals with the following nine instruments: *Svayaṃvaha-gola-yantra, Cakra, Dhanus, Kartarī, Kapāla, Pīṭha, Śaṅku, Ghaṭī* and *Yaṣṭi.*

Closely following these predecessors, Bhāskarācārya devotes, in the *Golādhyāya* of his *Siddhānta-śiromaṇi* (1150), an exclusive chapter entitled *Golabandhādhikāra* to the armillary sphere and a subsequent chapter called *Yantrādhyāya* to ten different types of measuring instruments and three varieties of perpetual motion machines. The instruments discussed by him are *Gola, Nāḍīvalaya, Ghaṭikā, Śaṅku, Cakra, Cāpa, Turya, Phalaka, Yaṣṭi* and *Dhī.* In addition, he discusses *Nalaka-yantra* in the *Tripraśnādhikāra* of the *Grahagaṇita.*

In his *Siddhānta-sundara* (1503), Jñānarāja also follows the same pattern of separate chapters for the armillary sphere and for other instruments; in the latter he describes *Turya, Chakra, Ghaṭī-yantra* and *Kāca-yantra,* and several automata.

CONTACT WITH ISLAMIC ASTRONOMY

Contact with Islamic astronomy led, from about the fourteenth century onwards, to the composition of texts exclusively devoted to instruments. The earliest work of this nature is the *Yantrarāja* composed by the Jaina monk Mahendra Sūri at the court of Fīrūz Shāh Tughluq in Delhi in 1370. In this first Sanskrit manual on the astrolabe, this instrument was called *yantrarāja,* 'king of instruments'. Astronomers also began to emphasise that astronomical studies remain incomplete without proper observational instruments. Thus Mahendra Sūri declares in his *Yantrarāja*:

> Though hardened in fierce battles,
> The soldier is defeated when deprived of weapons,

Though profound in the whole range of astral science,
The astronomer is disgraced without his instruments.'[16]

Writing about half a century later, in 1428, Rāmacandra Vājapeyin echoes the same idea in his *Yantra-prakāśa,* which is cited at the beginning of this Introduction.[17] In the subsequent centuries also, several Sanskrit works were composed on instruments. The astrolabe was discussed in more than a dozen Sanskrit texts, some of which were exclusively devoted to this instrument. These texts will be discussed in the introduction to section C on Sanskrit astrolabes.

Besides, there are also other texts which dealt with several instruments. Notable among these is Rāmacandra Vajapeyin's voluminous *Yantra-prakāśa* of 1428 in six chapters. Here the first four chapters are devoted to the astrolabe, the fifth chapter deals with the gnomon and staff, while the sixth chapter describes the construction and use of as many as 36 different types of instruments.[18] Viśrāma's *Yantra-śiromaṇi* of 1615 is a modest work which deals with six instruments, viz. *Nara-yantra* (gnomon), *Jala-yantra* (water clock), *Yantrarāja* (astrolabe), *Cāpa-yantra* (semi-circular instrument), *Turya-yantra* (quadrant) and *Nalaka-yantra* (sighting tube). Nandalāla Miśra's *Yantra-sāra* of 1772 discusses eleven instruments with special emphasis on the astrolabe and the quadrant.

There are also exclusive works on other instruments. About 1423 Padmanābha composed an exclusive text on the *Dhruvabhrama-yantra* which he had invented. Probably in the first half of sixteenth century, Cakradhara composed the *Yantra-cintāmaṇi* on the sine quadrant. The work must have been very popular; there exist several manuscript copies. Not so popular, but more comprehensive is Bhūdhara's *Turya-yantra-prakāśa* of 1572 on the sine quadrant, which text is available just in a single complete manuscript.[19]

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16 Mahendra Sūri, 1.4. Extracts from this text, together with translation, will be added in an appendix.

17 Rāmacandra Vājapeyin, 1.10.

18 Sarma 2008b.

19 SaKHYa 2014. It is beyond the scope of this catalogue to discuss these Sanskrit texts and the instruments mentioned there in greater detail. Some of these texts will be referred to while describing the extant instruments. Extracts from a few texts will also be reproduced with translation

This overview of Sanskrit texts on astronomical instruments raises the following questions. Were any of these instruments ever constructed and used in observation? Are there any specimens extant in museums in India or outside? If yes, are these extant instruments mentioned or described in literature? [20]

The study of scientific instruments in other culture areas is well developed. In the West, there are excellent museums of history of science and technology, such as the Museum of History of Science at Oxford, the Adler Planetarium at Chicago, and the Deutsches Museum at Munich. Also the literature on medieval European instruments and instrument-makers is truly impressive, beginning with Ernst Zinner's classic study *Deutsche und Niederländische Astronomische Instrumente*.[21] Islamic astronomical instruments like the astrolabe and the celestial globe have been catalogued and studied in several publications, notably in *A Computerized Checklist of Astrolabes* by Derek Price and his associates[22] and in the *Islamicate Celestial Globes, their History, Construction, and Use* by Emilie Savage-Smith.[23] Professor David King embarked on a path-breaking work of cataloguing medieval European and Islamic astronomical instruments,[24] and published a vast corpus of highly valuable work.[25]

In India, no comparable work has been done on the existing instruments. While studying Jai Singh's masonry instruments in the early part of the last century, Garrett and Kaye severally paid some attention to the portable instruments at Jaipur.[26] In 1921 Kaye also studied the four instruments acquired by the Archaeological Museum at

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in the Appendices. For more information on the instruments described in these Sanskrit texts, see Das 1928, Rai 1985, SarmaKV 1990, and all the papers by Yukio Ôhashi listed in the bibliography.

20 Rai 1985, after giving a lucid account of the instruments described in Sanskrit texts, concludes on p. 336: 'None of the instruments described by Indian astronomers before the time of Maharaja Jai Singh survive today. Perhaps they were made of perishable materials like wood and bamboo. Admittedly they were not very sophisticated. But it must be remembered that mechanical clocks had not been devised up to that time and it was not possible to measure time accurately.' Luckily, several specimens of the instruments described in the Sanskrit texts survive.

21 Zinner 1979.

22 CCA.

23 Savage-Smith 1985.

24 King 1991.

25 See, in particular, his recent publications like King 1999b, King 2004, King 2005.

26 Garrett & Guleri 1902, pp. 60-65; Kaye 1918, pp. 16-36.

Delhi.[27] In 1935 Sulaiman Nadvi brought to light a hitherto unknown family of instrument makers of Lahore by listing 8 astrolabes and 4 celestial globes manufactured by the various members of this family.[28] In the 1970s, S. N. Sen undertook a survey of 'Astronomical Instruments of Historical Importance,' and published an interesting study on the astrolabe.[29] Beyond this, nothing more came out of the project.[30]

However, the first steps towards a descriptive catalogue were taken by R. T. Gunther in his pioneering work, *The Astrolabes of the World,* where he published the descriptions of 25 Indo-Persian astrolabes and 9 Sanskrit Astrolabes, together with excellent photos.[31] Likewise, Emilie Savage-Smith's catalogue of *Islamicate Celestial Globes* of 1985 contains descriptions of several Indo-Persian celestial globes.

Following this lead, I began the survey of extant astronomical instruments produced in pre-modern India and now preserved in museums and in private collections in India, Europe and USA, and identified some 555 instruments of diverse types, belonging to the two broad categories of Sanskrit instruments and Indo-Persian instruments.

Indo-Persian Astronomical Instruments

Muslim astronomers in India cultivated the Middle Eastern tradition of astronomical instrumentation. They avidly studied and copied the Arabic and Persian texts on astronomy, astrology and astronomical instruments composed in the various parts of the Islamic world; this is attested by the rich collections of manuscripts in various libraries in India.[32] They may also have composed original works on astronomical instruments either in Arabic or Persian, but such texts are yet to be

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27 Kaye 1921.

28 Nadvi 1935.

29 Sen 1990.

30 Vijai Govind, Sen's assistant in this project, published two more papers: Govind 1979; Behari & Govind 1980. But there are serious flaws in these two papers in the identification of instruments. For the sake of comprehensiveness, three other papers may be mentioned here: Dvivedi 1923; Dube 1928; Stone 1958.

31 Gunther 1932: Indian astrolabes, nos. 67-91, 74a, pp. 179-220; Hindu astrolabes, nos. 92-98, pp. 221-228.

32 Rahman, Alivi, Khan & Murthy 1982; see also a critical review of this by Ansari & Fatima 1984.

surveyed. Immediately relevant for us is the fact that the Muslim astronomers in India produced a substantial number of Islamic, or more precisely Indo-Persian, astronomical instruments, mainly astrolabes and celestial globes, and a small number of other instruments like sine quadrants.

The production of Indo-Persian astrolabes in India may have begun at the court of Fīrūz Shāh Tughluq at Delhi in the second half of the fourteenth century, but the earliest extant dated astrolabe is of 1567. It was made by Allāhdād of Lahore. He and his six descendants dominated the production of astrolabes and celestial globes in the sixteenth and seventeenth centuries. Compared to the instruments made by this family, very few instruments by others outside this family are extant today. The instrument production in the Allāhdād family ceased after 1691. Hardly any Indo-Persian instruments bearing dates in the eighteenth century came to light. But this does not mean that the production of astrolabes or celestial globes ceased completely in the eighteenth century, because there exist quite many instruments fabricated in the nineteenth century. It is possible that some of the extant unsigned and undated astrolabes and celestial globes may have been produced in the eighteenth century. But what seems to be certain is that with gradual decline of the Mughal empire, patronage also declined for astronomical instruments, as a consequence of which not many large and ornate astrolabes and celestial globes with the names of makers and dates may have been made in the eighteenth century.

Although there is a kind of vigorous revival of the production of Indo-Persian astrolabes and celestial globes towards the middle of the nineteenth century, as will be shown below, the geographical extent of their production was limited only to the Punjab-Delhi region.

Sanskrit Astronomical Instruments

On the other hand, one would expect that Sanskrit astronomical instruments, unlike the Indo-Persian instruments, were manufactured throughout India. But surprisingly, their production, with the exception of the armillary spheres and water clocks, was also largely confined to the region comprising Gujarat, Rajasthan and Punjab, where it continued in the eighteenth and nineteenth centuries as well. I am unable to explain this anomaly. After all, there has been no discernable break in the study of Sanskrit astronomy in the southern and eastern parts of India. This is attested

by manuscripts of all of major Sanskrit texts copied in all parts of India and in all regional scripts. In the fifteenth and sixteenth centuries Kerala made great advances in mathematical astronomy. A central figure of these advances, the great Nīlakaṇṭha Somayājin enjoins that only such astronomical treatises should be followed which agree with actual observations.[33] This statement presupposes the existence of instruments for astronomical observation. Yet no astronomical instruments of any consequence were found there.

The earliest dated Sanskrit instrument is an astrolabe (C001) which was completed on Sunday, 25 December 1605, at Ahmedabad. It was commissioned by the astrologer Caṇḍīdāsa for his son Dāmodara. One may wonder why no Sanskrit astronomical instrument made earlier than this date is available. I have shown elsewhere that the custom of engraving the name of the maker and the date of production on metal instruments and other objects was introduced into India along with the astrolabe.[34] Of course, stone epigraphs in India carried often the date and the name of the king who issued the epigraph, the name of the poet who composed the text and the name of the artisan who incised the inscription. The practice was followed later in copper plate epigraphs and in manuscripts as well. But there was no custom of engraving the name of the maker and date on metal artefacts before the introduction of the astrolabe.[35] Another reason for the absence of Sanskrit instruments made before the seventeenth century is that often brass instruments not in use were recycled to produce other objects.

As mentioned above, the earliest extant Sanskrit astrolabe was made in Ahmedabad in Gujarat. Some other early astrolabes also emanate from Gujarat. From there, the production spread to Rajasthan, where it received an impetus at the court of Sawai Jai Singh in the early eighteenth century. It is well known that Sawai Jai Singh (1688-1743) designed huge masonry instruments for accurate observations and with

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33 Nīlakaṇṭha Somayājin, *Jyotirmīmāṃsā,* p. 6: *yaḥ siddhāntaḥ darśanāvisaṃvādī bhavati so 'nveṣaṇīyaḥ,* quoted in: Subbarayappa & Sarma 1985, p. 7; for similar statements by other astronomers, see ibid, pp. 5-8.

34 Sarma 2010.

35 Interestingly on a Sanskrit astrolabe of 1605 (C001), the style of the inscription followed that of Sanskrit manuscript colophons, even though the custom of engraving the date and the name of the person who caused to be made was borrowed from Islamic practice. Therefore, Pingree dismissed the astrolabe as late production. For his arguments and for my refutation, see Sarma 2012c.

these he set up five observatories at Delhi, Jaipur, Varanasi, Mathura and Ujjain. But he did not neglect portable instruments. He was a great admirer of the astrolabe. He collected some of the best Mughal astrolabes, to some of which he caused Sanskrit legends to be added. He also appears to have established a workshop at Jaipur to produce Sanskrit astrolabes. Here were produced some ornate astrolabes with multiple plates, designed after the Indo-Persian astrolabes of the Lahore family (C021 and C022). But, the main products of this workshop are astrolabes with single plates calibrated to the latitude of Jaipur at 27°. Jai Singh seems to have got a large number of such astrolabes fabricated and distributed them among the astronomers of his court, so that they became proficient in the science of the astrolabe. In the stores of Jai Singh's Observatory at Jaipur, I discovered a number of unfinished astrolabes belonging to this workshop (D078-D086).

But production of Sanskrit astronomical instruments was not confined to Jaipur in the eighteenth century. Instruments were made and collected also at several other kingdoms in Rajasthan, and also in Gujarat.

In the nineteenth century, western sciences, including astronomy, began to be taught in universities and colleges throughout India and modern observatories were set up at several places with telescopes and related instruments. But these activities did not completely replace the Sanskrit and Islamic traditions of astronomical learning and the production traditional astronomical instruments. At some places, the traditional Sanskrit or Islamic learning flourished side by side with western sciences; at others there is an amalgamation of both the streams in varying proportions. This is true also of scientific instrumentation. Sanskrit astronomical instruments continued to be manufactured mainly in Rajasthan. A new centre of production came up at Kuchaman, which is situated some 130 km west of Jaipur, but roughly on the same latitude of 27°. Here were produced Sanskrit astrolabes, the last of which (D037) was completed on Monday, the sixth day of the bright half of Kārtika in the year 1960 of Vikrama Saṃvat (= Monday 26 October 1903).[36]

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[36] In the latter half of the nineteenth century, Sāmanta Candraśekhara designed in Orissa his own astronomical instruments out of bamboo and wood and made systematic observations and

Indo-Persian astrolabes and celestial globes continued to be made in Punjab, mainly at Lahore, in the nineteenth century. At Aurangabad in Maharashtra (19;53 N, 75;23 E), there flourished an astrolabe maker Muḥammad Mūsa Asṭurlābī in the 18th century. A celestial globe made by his grandson Muḥammad Faḍl Allāh in 1808 (presumably at Aurangabad) survives today. This globe is mounted on a European style stand into which a magnetic compass is incorporated.[37] In the east, at Tikari in Bihar (24;57° N, 85;53° E), Ghulām Ḥussayn Jaunpūrī made a celestial globe in 1816.[38] But these are exceptions and not the rule. The production of Indo-Persian astrolabes and celestial globes was centred primarily at Lahore. Towards the middle of the nineteenth century, there was a sudden upsurge in the manufacture of these traditional astronomical instruments at Lahore under the aegis of a Hindu by name Lālah Bulhomal Lāhorī, who crafted astrolabes and celestial globes with legends either in Arabic-Persian or in Sanskrit. He also crafted Sanskrit instruments like *Dhruvabhrama-yantras* and *Turīya-yantras*, signing his name in pretty Sanskrit verses. He even created some new instruments of his own design. Some forty-five instruments of diverse types at Lahore made by him and by his Hindu and Muslim associates are known. Bulhomal can be regarded as the last representative of both Islamic and Sanskrit traditions of astronomical instrumentation.[39]

Although the telescope and the pendulum clock were widely available, it is interesting to note that Indian craftsmen copied European models of naked eye instruments, like ring dials, and engraved on them Persian legends for the sake of Muslim astrologers and Sanskrit legends for the use of Hindu *jyotiṣīs*. A scientific instrument that is still produced today at Muradabad in Uttar Pradesh, quite elegantly and in large numbers, is the perpetual calendar. Two nineteenth-century prototypes are preserved in the Victoria and Albert Museum at London and in the Rampur Raza Library. These will be described in section T.

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composed the *Siddhānta-darpaṇa* in Sanskrit; on his work, see Misra 1996; Naik & Satpathy 1995 Naik & Satpathy 1998; Naik 2000.

37 Preserved at the Salar Jung Museum, Hyderabad; cf. Sarma 1996a, pp. 27-28, pl. 15.

38 Cf. Ansari & Sarma 1999-2000.

39 For a comprehensive study of his oeuvre, see Sarma 2015b.

To sum up, the instruments which are extant today were produced between the mid-sixteenth century and the end of the nineteenth century, mainly in the region of Gujarat, Rajasthan and Panjab.

CATALOGUING ASTRONOMICAL INSTRUMENTS

In his *The Astrolabes of the World* of 1932, Robert T. Gunther described 317 standard astrolabes, 8 mariner's astrolabes and 11 astrolabe clocks. He also included six ancient and medieval texts on the construction and use of the astrolabe, which is indeed laudable.[40] Derek J. de Solla Price of Yale University and his associates, Sharon L. Gibbs and Janice A. Henderson, prepared in 1973 *A Computerized Checklist of Astrolabes* (= CCA). This list provides the date, reference number, diameter, equinox, precession, type and maker for over 1700 extant astrolabes produced in several cultural areas. Alain Brieux and Francis Maddison embarked on the compilation *Répertoire des Facteurs d'Astrolabes, et leurs oeuvres. Islam, plus Byzance, Arménie, Géorgie et Inde Hindoue* (= Répertoire) as an expanded version of L. A. Mayer's *Islamic Astrolabists and Their Works* (Geneva 1956). This compilation is arranged by the names of instrument makers and lists under each name the various instruments made by this maker in a chronological sequence. The value of the compilation lies in the fact that it provides, besides the date, size, components of the instrument and the bibliography on it, also the full text of maker's signature in original language together with a translation in French. Unfortunately, this very useful compilation was never published.[41] David King began to extend the CCA list by assigning numbers beyond 4000 in some of his publications under the rubric 'International Instrument Checklist' (= IIC). But this new list has not been published in a consolidated form so far.

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40 These texts are: John Philoponus of Alexandria, *ca.* AD 625, English translation of the Greek text (pp. 61-81); Severus Sebokt, *ca.* AD 650, English rendering of the Syriac text (pp. 82-103); Henry Bates, Malines, Belgium, *Magistralis Composito Astrolabii* of 1274 (pp. 368-376); Hermannus Contractus, b. 1013, Reichenau, Germany, *De Mensura Astrolabii* (pp. 404-408); idem, *De Utilitatibus Astrolabii* (pp. 409-422); Robert Tanner, *The Travailer's Joy*, facsimile of the London print of 1587 (pp. 502-508).

41 Francis Maddison allowed me in 1993 to copy the pages dealing with Indian instrument makers. In early 2013, somebody told me in Paris that the Répertoire was being printed, but I did not hear anything concrete thereafter.

The Mariner's astrolabe is a drastically simplified version of the standard astrolabe for taking altitudes at the high seas. As mentioned above, Gunther described 8 extant specimens (nos. 318-325) in his work. A complete inventory of all the extant specimens was published in 1988 by Alan Stimson in his *The Mariner's Astrolabe. A Survey of known, surviving Sea Astrolabes.* Mariner's astrolabes were not made in India, but an undated specimen survives in the Raza Library of Rampur.[42]

Emilie Savage-Smith prepared a descriptive catalogue of 132 Islamic celestial globes, which include several pieces made in India.[43] In a subsequent publication, she mentions that the total number of extant Islamic celestial globes stands at 175.[44]

In his publication mentioned above, Gunther describes 25 Indo-Persian astrolabes under the heading 'Indian astrolabes' and 9 Sanskrit Astrolabes as 'Hindu astrolabes'. Otherwise Sanskrit astrolabes have not been discussed systematically so far, but for the few specimens at the Time Museum described by Anthony Turner[45] and at the Adler Planetarium by David Pingree.[46] Other Sanskrit instruments were not discussed at all in any of the publications. A large group of over 200 Sanskrit astrolabes and other kinds of instruments are described here for the first time. As Derek Price aptly remarked, '[e]ach instrument is a valuable document in itself, yielding historical and scientific data often unobtainable elsewhere. … however … the full significance of any one instrument cannot be properly realised except by comparison with the corpus of all such instruments extant.'[47]

PRESENT CATALOGUE

The present descriptive catalogue aims to study each instrument in the context of all the related extant specimens. Therefore, each instrument type is organized in a separate section identified by the letters of the alphabet. These sections begin with

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[42] See Sarma 2003, pp. 58-59.

[43] Savage-Smith 1985.

[44] Savage-Smith 1990.

[45] Turner 1985.

[46] Pingree 2009.

[47] Price 1955, p. 243.

introductory essays on the history of the instrument type and its varieties, followed by the catalogue of the extant specimens. There are also introductory essays on instrument makers. Extracts from some Sanskrit texts describing the construction and use of certain instruments will be given in appendices, together with translations. In the descriptions of individual instruments, all engraved data are reproduced and interpreted as far as possible.[48]

The Lahore instrument makers generally engrave their names and the year of production. Such instruments are arranged chronologically. But sometimes they omit the dates. Such pieces are arranged by the size. Several astrolabes and celestial globes carry neither names nor the dates, some of which can be attributed to a particular maker on stylistic grounds. These too are arranged by size.

Sanskrit instruments do not always carry the names of the makers and the dates of manufacture. Where these are available, the instruments are arranged in chronological order. Otherwise, sometimes instruments with similar features are grouped together, some other times according to the place of production and so on.

The listings in the CCA and in the Répertoire are not based on personal examination, but often on the basis of the data provided by the authorities of the collections. The CCA assigns sometimes two separate numbers to the same instrument, other times it wrongly attributes instruments to a specific collection. Such discrepancies are corrected to a certain extent in the Répertoire. Therefore, under each astrolabe, I give the reference number from both these compilations. Likewise, in the case of Indo-Persian celestial globes, I refer to the serial numbers in Emilie Savage-Smith's work with the prefix ESS. In this catalogue, each instrument is given an identification code, beginning with a letter of the alphabet and followed by a three-digit serial number. Instruments which I have personally examined are marked with the symbol ⊙. Thus the fitst entry in the catalogue is marked A011⊙.

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48 The working conditions and the time at my disposal varied from place to place. In several museums, I had to study and photograph the instruments in the display rooms in the midst of visitors who paused to stare at me, or in the open sun. Consequently, the extent of my descriptions and the quality of my photos also vary.

A. INDO-PERSIAN ASTROLABES BY THE LAHORE FAMILY

عشق اسطرلاب اسرار خدا است

^{c}ishq usturlāb isrār-i khudā ast

Love is the astrolabe of the mysteries of God.

— Jalāluddīn Rūmī (13th century)

यस्मिन् करामलकवद् विदिते विदितं भवेद् विश्वम्॥

yasmin karāmalakavad vidite viditaṃ bhaved viśvam

When you know the astrolabe well,
you will know the universe
like a fruit on the palm of your hand.
— Rāmacandra Vājapeyin (1428)

A Mirror for Mathematiques, a Golden Gem for Geometricians,
a Sure Safety for Saylors,
and an auncient Antiquary for Astronomers and Astrologians.
— Robert Tanner (1587)

INTRODUCTION

1. Planispheric Astrolabe

The astrolabe is a highly sophisticated astronomical instrument of the Middle Ages, which held its sway from Geoffery Chaucer's England in the west to Firūz Shāh Tughluq's Delhi in the east.[49] It was widely used for observation and computation. As an observational instrument, it was employed in measuring the altitudes of the heavenly bodies and also for ascertaining the heights and distances in land survey. As a computational device, it can be made to simulate the vault of the heavens at any given locality and time. Then one can read off from the dial the time and also note the times of Islamic prayers. One can also directly read off the ascendant for that moment and the other three points where the ecliptic intersects the horizon and the meridian, without resorting to complicated calculations. The knowledge of the these four points (called 'pivots', *atwad* in Arabic) on the ecliptic is essential for casting horoscopes, or for determining the auspiciousness or otherwise of a given moment. More important, the astrolabe works as an analog computer and can be used to solve a number of trigonometrical problems. Jābir al-Ṣufī is said to have listed one thousand problems that can be solved with the astrolabe.[50]

No wonder, the Jaina monk Mahendra Sūri bestows on the astrolabe the Sanskrit name *yantra-rāja* (the king of instruments). Rāmacandra Vājapeyin declares that if one knows the astrolabe well, one will know the universe like a small fruit on the palm of one's own hand (*yasmin karāmalakavad vidite viditaṃ bhaved viśvam*). For Jalāluddīn Rūmī, the famous mystic poet, astrolabe is the sublime metaphor for measuring the immeasurable and for comprehending the incomprehensible. Thus he says: *ishq usturlāb isrār-i khudā ast,* 'love is the astrolabe of the mysteries of God.' Robert Tanner invested

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49 The literature on the astrolabe is voluminous, running into some 2000 titles. For the best technical introduction, see Hartner 1968a; Hartner 1968b; North 1974; Pingree 1985; Turner 1985; Proctor 2005; **Error! Reference source not found.**; Graaf 2011; an important Indian contribution is Khareghat 1950.

50 Michel 1976, p. 83, quips: 'We should be thanked for not taking up the 25 questions expounded by Severus Sebohkt about the year 650, the 43 of al-Khwārizmī about 840, the 21 of Hermann le Boiteux in 1054, the 64 of Blundeville in 1613, to say nothing of the 103 problems of Clauvious and 1000 of Jabir al-Suf.'

his book on the construction and use of the astrolabe with a double title, heaping rhyming epithets on this wonder-instrument. He named the book *The Travailers Joy and Felicitie,* with a subtitle, *A Mirror for Mathematiques, A Golden Gem for Geometricians, A Sure Safety for Saylors, and an auncient Antiquary for Astronomers and Astrologians.*'[51]

The astrolabe, or more correctly the planispheric astrolabe, is the representation of the three-dimensional celestial sphere on a two-dimensional plane by stereographic projection. Stereographic projection is a projection of the sphere from one of its points onto the plane which is parallel to the plane tangent to that point. This projection has two essential properties. First, the circles on the sphere are projected on the plane as circles; or, if the circles on the sphere pass through the centre of projection, they are projected as straight lines. Second, the angles between intersecting circles on the sphere remain unchanged when projected on the plane.[52]

Besides the planispheric astrolabe, there are two other varieties, viz. the spherical astrolabe[53] and the linear astrolabe,[54] where the projection of the heavens is made respectively onto a sphere and onto a straight line. But these are mere theoretical curiosities and do not have much practical relevance. Therefore, generally whenever the word 'astrolabe' is used, it means the planispheric astrolabe.

Again, the planispheric astrolabe itself can be of different types. The most common type is the northern astrolabe (Arabic: *asṭurlāb shamālī*). Here the stereographic projections on the rete and on the plates are so made that the celestial North Pole becomes the centre of the astrolabe and the outermost periphery is formed by the Tropic of Capricorn. Therefore, on the rete of such an astrolabe, the positions of only those stars can be shown that lie to the north of the Tropic of Capricorn.

In the southern astrolabe (*asṭurlāb janūbī*), on the other hand, the centre is formed by the celestial South Pole and the outer periphery by the Tropic of Cancer. On its rete

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51 Printed at London in 1587; reproduced in facsimile in Gunther 1932, pp. 524-534.

52 Morrison 2007, pp. 45-57.

53 On spherical astrolabe, see Hartner 1968b, pp. 317-318; Maddison 1962; Canobbio 1976.

54 Morrison 2007, pp. 287-293.

can be shown those stars lying to the south of the Tropic of Capricorn and visible to an observer in the northern temperate zone of the earth.[55]

On the relative advantages of the two varieties, Henri Michel states as follows:[56]

> The sky north of the Tropic of Capricorn contains almost everything visible in northern temperate latitudes. Clearly, the northern astrolabe is much better suited for representing the stellar vault for the northern hemisphere, at least for us who live here.
>
> In both the northern and southern astrolabes the instrument provides the north face of the plane of projection. Therefore, we see constellations in the same order as on the southern astrolabe with the apparent motion of the heavens always moving clockwise and longitude and right ascension [increasing] in the opposite direction. The sense of declination is reversed in the southern astrolabe with positive declinations outside the equator.
>
> The southern astrolabe offers advantages if we consider only the apparent position of the Sun. The daily motion of the Sun in summer, when it is between the equator and the Tropic of Cancer, is projected along a longer arc than in winter and the Sun appears higher above the horizon. The apparent motion, therefore, approximates what we are accustomed to seeing. When construction of large clocks began in the fourteenth century, the clockmakers tried to reproduce the Sun's apparent motion. To this end, they used stereographic projection and gave preference to the southern astrolabe projection for these reasons. The oldest astronomical clocks were configured in this way. The primary use of southern astrolabe face has been on monumental clocks and few examples exist on hand held instruments.

The features of the northern and southern astrolabes are combined in the composite astrolabe, called the north-south astrolabe (*asṭurlāb shamālī wa janūbī*), so that it can display the stars belonging both to the northern and the southern celestial hemispheres. These last two varieties are again theoretical curiosities. Very few of such

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[55] On southern astrolabes, see Morrison 2007, pp. 155-158.

[56] Michel 1976, pp. 12-14.

southern or north-south astrolabes were actually manufactured. Thus the standard variety is the planispheric northern astrolabe. This is the type which was commonly used and which was produced in great numbers in all the cultures where the astrolabe was cultivated. Therefore, henceforth we use the expression ‘astrolabe’ in the sense of this standard astrolabe, viz. the planispheric northern astrolabe.

1.1. The Astrolabe in Antiquity

The astrolabe was invented in Hellenistic antiquity, but it is not known precisely when or by whom. However, the stereographic projection underlying the construction of the astrolabe is said to have been developed by Hipparchus of Alexandria in the second century BC. Claudius Ptolemy in the second century AD was familiar with the instrument but not with its present name. In the sixth century AD, John Philoponus of Alexandria wrote a treatise in Greek on this instrument; it is the earliest extant text to describe the construction and use of the astrolabe.[57] By this time, the astrolabe was fully developed, for Philoponus mentions all the principal components. In the seventh century, Bishop Severus Sabokt of Nisibis in Syria composed a treatise in the Syriac language, which also survives.[58] Otto Neugebauer is of the view that both these treatises were based on a fourth-century work by Theon of Alexandria which is no more extant.[59] Nor did any actual specimen survive from this period.

1.2. The Astrolabe in the Islamic World

From Hellenistic antiquity, the science of the astrolabe spread, through Syriac stages, to the Islamic world where it attained the highest popularity. Like much of Greek science and philosophy, the science of the astrolabe was also preserved, elaborated upon and disseminated further by the Islamic world.[60] By the ninth century, the astrolabe attained such a pre-eminent position in Islamic civilization that several treatises were

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57 Philoponus, ‘Treatise on the Astrolabe. in: Gunther 1932, pp. 61-81; see also Drecker 1928.

58 Sabokt, ‘Treatise on the Astrolabe’ in: Gunther 1932, pp. 82-103.

59 Neugebauer 1949.

60 On the reception of Greek science in the Islamic world, see, among others, Gingerich 1986; Sabra 1987; Gutas 1998.

composed in this century in Arabic on this instrument.[61] It has been thought for long that Māshā'allāh, a famous astrologer and astronomer at the court of the Caliphs at Baghdad, composed one of the earliest treatises on the astrolabe which survives in Latin translations. But Kunitzsch has shown that 'nothing of the popularized treatise on the composition and the use of the astrolabe generally ascribed to Messahalla can be traced back to this author.'[62] However, there are several other works on the astrolabe that were composed in Arabic in the ninth century. Al-Khwārizmī (ca. 825) wrote two small treatises, one on the construction and the other on the use of the astrolabe. The larger one on the use of the astrolabe is the earliest extant Arabic text on this subject.[63] A literal translation of this treatise on the use of the astrolabe was incorporated in the *Sententie Astrolabii,* a Latin text which was compiled in Spain in the late tenth century. This is the oldest extant medieval western text on the astrolabe.[64] Of the other texts composed in Arabic in the ninth century, there survive a treatise, entitled *al-Kāmil,* by Aḥmad ibn Muḥammad ibn Katir al-Farghānī (ca. 857) on the construction of the astrolabe and another on its use by ᶜAlī ibn ᶜĪsa al-Asṭurlābī al-Ḥarrānī (ca. 880).[65] Al-Farghānī was at the court of the Abbasid Calif al-Ma'mūn in Baghdād; later he moved to Egypt where he composed the *al-Kāmil* in 7 chapters.[66] In the earlier chapters of this work, he discusses the mathematical principles of stereographic projection and provides elaborate tables to help the construction of astrolabes. In chapter 5, he teaches how to construct the northern astrolabe. Interestingly, in the following chapter, he also teaches the construction of the southern astrolabe. Al-Farghānī also compiled a set of tables to facilitate the production of latitude plates; these tables, containing over 13,000 entries,

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61 For an overview of the literature on the astrolabe, see Lorch 2005b.

62 Kunitzsch 1959.

63 It is edited with a translation and commentary by François Charette and Petra Schmidl; see Charette & Schmidl 2004.

64 Kunitzsch 1989d.

65 For an excellent overview of the extant treatises on the astrolabe and of the actual specimens in the Islamic world and in Europe, see Stautz 1999, pp. 1-98.

66 Arabic text, edited with translation by Lorch 2005a.

provide the radii and centre distances of altitude circles and azimuth circles for each degree of altitude and each degree of azimuth, for each degree of terrestrial latitude.[67]

In the production of the astrolabe also, the Islamic world achieved high excellence. Indeed, the production of precision instruments can be said to originate in the manufacture of astrolabes in the Islamic world. Thus the Islamic world did not just receive and preserve the science of the astrolabe, which in itself would have been remarkable. It made significant contributions to the theory and practice of the astrolabe. Moreover, the Islamic world also disseminated the science of the astrolabe, westwards up to England and eastwards up to India. As North observes, '[b]efore the end of the 13th century the planispheric astrolabe was known and used from India in the east to Islamic Spain in the west, and from the Tropics to northern Britain and Scandinavia.'[68] Therefore, the astrolabe can be regarded as the finest gift of the Islamic world to scientific instrumentation. Oliver Hoare has correctly observed that '[t]he ability of Islamic civilization to perfect what it inherited, and to endow what it made with beauty, is nowhere better expressed than in the astrolabe.'[69]

In the Islamic world, the astrolabe (*aṣṭurlāb* or *aṣṭurlāb*) and the celestial globe (*al-kura*) were the most popular astronomical instruments, and the usual mode of describing a good astronomer was to say that he was adept in the use of the astrolabe and the celestial globe. Astrolabe making became an important profession in the ninth century and the sobriquet *al-Asṭurlābī* indicated a high professional status because the construction involved not just skill in metal-craft but also sound knowledge of astronomy and trigonometry.

Of the early astrolabes made in the Islamic world, there survive some Abbasid astrolabes, but these are not dated.[70] The earliest dated astrolabe which is extant is by Muḥammad ibn ᶜAbd-Allāh Nasṭūlus. Four astrolabes by him are known. One of these is dated in 315 AH (AD 926-27). It is preserved in the Islamic Archaeological Museum,

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67 King 1987b, p. 5.

68 North 1974.

69 Oliver Hoare, in: *The Unity of Islamic Art,* Riyadh 1985, p. 81, cited by King 1995, p. 76.

70 One of these is described by King 2005, pp. 402-437: 'The oldest known astrolabe from the late 8th-century Baghdad'

Kuwait. It has a diameter of 173 mm. The rete and alidade are lost, but the mater and one plate are extant. The two sides of the plate are calibrated for latitudes 33° (Baghdad, Damascus) and 36° (Mosul, Rayy, middle of the fourth climate). The rim of the front is marked for 1° and 5°. On the back, there are four altitude scales on the rim and one circular shadow scale. Otherwise, the back is blank.[71]

The second astrolabe by Nasṭūlus is in Cairo; here only the mater survives with a gazetteer on the front and trigonometric quadrants on the back. The third astrolabe is said to be in London; the rete and alidade are missing; there remain two plates for latitudes 31°, 32°, 33° and 34°. The fourth one, now at the Museum of Islamic Art in Doha, Qatar, is engraved with concentric solar and calendar scales on the rim in the front. It is not exactly an astrolabe in the conventional sense; it is made more for trigonometric and calendrical calculations.[72]

The few surviving astrolabes and their fragments from the ninth century are somewhat plain devices without any ornamentation. Real ornamentation and sophisticated design began to develop in the tenth century. In this connection, the astrolabe made in 374 AH (AD 984-85) by Ḥāmid ibn Khiḍr **al-Khujandī** with elegantly designed rete and throne represents an important landmark in astrolabe production.[73] Khujandī was an eminent astronomer, mathematician and instrument maker. He constructed a large sextant, with a radius of over 20 metres at Rayy (near modern Tehran) and named it *Suds Fakhrī* (Fakhrī sextant) after his patron Fakr al-Dawla, the Buyid ruler of Iran (r. 977-997).[74] With this sextant, he determined the obliquity of the ecliptic as 23;32,21°.[75]

In contrast, the astrolabe he made is rather small with a diameter of 151 mm, but he equipped it for the first time with many features which were taken up by the

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71 King 1995, pp. 76-83.

72 Described in King 2008, where references are made to the second and third astrolabes.

73 Described and illustrated in King 1995 and more elaborately in King 2005, pp. 503-517; 940-941; see also Graaf 2011.

74 This sextant does not exist anymore; a similar sextant, of twice this size, was erected in 1420 in the Samarqand observatory, which is now in ruins. The only extant functional specimen of the Fakhrī sextant can be seen in Jai Singh's observatory at Jaipur under the name *Vṛtta-ṣaṣṭāṃśa-yantra*; cf. Sarma 1986-87b.

75 King 1995, p. 83.

subsequent astrolabe makers, in particular, by the Lahore family of astrolabe makers. King considers that this astrolabe 'represents the culmination of known Muslim achievements in astrolabe construction in the early period.'[76] The *kursī* is worked *à jour* with two lion's heads facing each other. In the rete also attempts are made to make it ornate with six star pointers shaped like bird's heads with long beaks. In the vertical axis are incorporated a quatrefoil, an ornament shaped like an inverted heart with little wings on either side, and a crescent. There are 33 star pointers, which is a fairly large number.

While the five plates serve latitudes 21°, 27°, 30°, 33°, 36° and 39°, projections for latitude 42° are engraved on the inner side of the mater. More important, there are four plate faces which occur here for the first time. The first is a plate for multiple horizons with declination scales, which was orgiginally invented by Ḥabash al-Ḥāsib at Baghadad in the ninth century. The second is a plate for the complement of the obliquity. Taking the obliquity as 23;33°, Khujandī designed the plate for latitude 66;27° (i.e., 90° – 23;33°) with a maximum duration of the daylight 24 hours. On the back of this plate is a double projection for 0° and 90°; here the maximum lengths of the daylight are stated to be 12 hours and 6 months respectively. These serve mainly pedagogic purposes and satisfy intellectual curiosity.

Another plate which also occurs for the first time is marked with astrological houses, each divided into decans, for the latitude of 33° (Baghdad). King states that the plate 'serves to facilitate the otherwise laborious computations relating to the astrological doctrine of casting the rays and is so designated in the cartouche (*maṭraḥ al-shu*ᶜ*ā*ᶜ *wa-huwa 'l-tasyīrāt*).'[77]

On the back, altitude scales are drawn on the upper half of the rim and a cotangent scale for a base of 12 on the lower half. In the upper left is a trigonometric quadrant with 90 horizontal lines. In the upper right is a solar quadrant with declination arcs upon which a horary quadrant for latitude 33° is superimposed. In the lower half there are several astrological tables in 8 semi-circular scales, containing the names of the 28 lunar

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76 King 1995, p. 83.

77 King 2005, p. 514.

mansions; the names of the 12 zodiac signs; the limits of signs and their regents; the regents of the decans; triplicities and the diurnal and nocturnal regents. As will be seen later, many of these features are emulated in the Lahore astrolabes.

In the subsequent centuries, astrolabe production spread to different centres which in course of time developed regional variations in technical details and ornamentation, especially in the Eastern (*Mashriq*) and the Western (*Maghrib*) parts of the Islamic world.[78]

1.3. The Astrolabe in Europe

From the Islamic world, the astrolabe was transmitted to Europe through Catalonia in Spain where a large number of Arabic texts were translated into Latin. Kunitzsch remarks that '[t] he oldest Latin texts on the astrolabe from the late tenth century show that those Christian scholars had at their disposal both Arabic texts and instruments and, as it seems, also the help of native speakers of Arabic.'[79] One of the earliest Latin treatises on the use of the astrolabe is attributed to Gerbert of Aurillac, who later became Pope Sylvester II (930-1003). It has already been mentioned that one of the earliest compilations made in Latin was the *Sententie Astrolabii* and that its third section dealing with the uses of the astrolabe was a literal translation of a treatise by Al-Khwārizmī.

In the subsequent centuries, the science of the astrolabe spread to much of Europe where a large number of treatises were composed. Notable among them is *A Treatise on the Astrolabe,* also known as *The Conclusions of the Astrolabie* or *Bread and Milk for Children,* composed by Geoffrey Chaucer about 1393. Instead of the customary practice of writing scientific texts in Latin, Chaucer was the first to write such a text in English, for the sake of his son Lewis, whom he addresses thus at the beginning of the work:

> Little Lewis my son, I perceive that thou wouldst learn the Conclusions of the Astrolabe; wherefore I have given thee an instrument constructed for the latitude of Oxford, and propose to teach thee *some* of these conclusions. [...] This treatise, divided into five parts, I write for thee in English, just as Greeks, Arabians, Jews, and Romans were accustomed to write such things

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78 For a fine analysis of these regional variations, see Gibbs & Saliba 1984, pp. 22-60.

79 Kunitzsch 1998, p. 114.

> in their own tongue. I pray all to excuse my shortcomings; and thou, Lewis, shouldst thank me if I teach thee as much in English as most common treatises can do in Latin.[80]

Production of the astrolabe also spread to other European countries, gradually giving rise to regional variations as in the Islamic world. The earliest extant European astrolabe is known as the Carolingian astrolabe. It was produced in the late tenth century in Catalonia, in Spain.[81] Astrolabe production reached its highpoint in Renaissance Europe, where some of the artistically beautiful specimens were produced, notably in Prague by Erasmus Habermel, the instrument maker of Rudolph II, towards the end of the sixteenth century.[82]

The astrolabe was popular in Europe up to the seventeenth century until the invention of the telescope. But it left a permanent imprint in another respect. A large number of Arabic technical terms which reached Europe through the astrolabe still survive in all the European languages. Thus, for example, 'zenith,' 'nadir' and 'azimuth' are derived from the Arabic.[83] Several of the star names used in European languages are likewise directly taken from the Arabic astrolabes, such as 'Altair' (from *al-Nasr al-Ṭā'ir* for α Aquilla), 'Caph' (from *Kaff al-Khaḍīb* for β Cassiopeiae), or 'Algol' (from *Ra's al-Ghūl* for β Persei) and so on.

1.4. The Lahore Family of Astrolabe Makers

The astrolabe may have been introduced into India in the eleventh century by Al-Bīrūnī who wrote extensively on this instrument. In the following centuries, scholars migrating from Central Asia to the court of the Sulṭāns at Delhi brought astrolabes with them and employed them here. The manufacture of the astrolabe appears to have commenced in India in the second half of the fourteenth century under Sulṭān Fīrūz Shāh Tughluq (r. 1351-1388). The *Sīrat-i Fīrūz Shāhī*, an anonymous chronicle of his rule composed in 1370, has a long account on the astrolabes manufactured under instructions

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80 This is a paraphrase in modern English of Chaucer's Middle English, by Skeat, cf. Chaucer, pp. 175-176.

81 King 1996b.

82 For an overview of European astrolabes, see Gunther 1932; Stautz 1999, pp. 65-98.

83 Kunitzsch 1984.

from Fīrūz.[84] However, none of these astrolabes survive today. Fīrūz also sponsored the composition of manuals on the astrolabe both in Persian and Sanskrit. The Persian manual does not survive any more save in extracts in the *Sīrat-i Fīruz Shāhī*. The Sanskrit manual entitled *Yantrarāja* , which was composed by a Jaina monk Mahendra Sūri in 1370, is extant and published.[85]

The earliest extant astrolabes in India pertain to the Mughal period. Among the Mughal emperors, Humāyūn (r. 1530-1556) was much interested in astronomy, astrology and astronomical instruments.[86] He is said to have 'extra-ordinary excellence in the astrolabe, globe and other instruments of the observatory.' Abū al-Faḍl, minister and chief chronicler of Humāyūn's son Akbar, speaks in glowing terms of Humāyūn's interest in astronomy. At one place he refers to Humāyūn thus: 'His Majesty, who in astrolabic investigations and studies in astronomical tables and observations was at the head of the enthroned ones of acute knowledge and who was a second Alexander....'[87] Elsewhere, employing an astrolabic metaphor, he calls Humāyūn 'the alidade of the astrolabe of theory and practice.'[88] Under Humāyūn's patronage, manufacture of astrolabes and celestial globes commenced at Lahore.[89]

The master craftsman (*ustād*) Allāhdād of Lahore and his descendants of four generations dominated the production of astronomical instruments in Mughal India in the second half of the sixteenth century and in the seventeenth century. [90] Neither the names of any members of this Lahore family, nor the instruments produced by them are mentioned in the contemporary documents. The history of this family and of their work

84 Sarma 2000.

85 Mahendra Sūri

86 On his interest in astrology, see Orthmann 2008.

87 Abū al-Faḍl 1, p. 123.

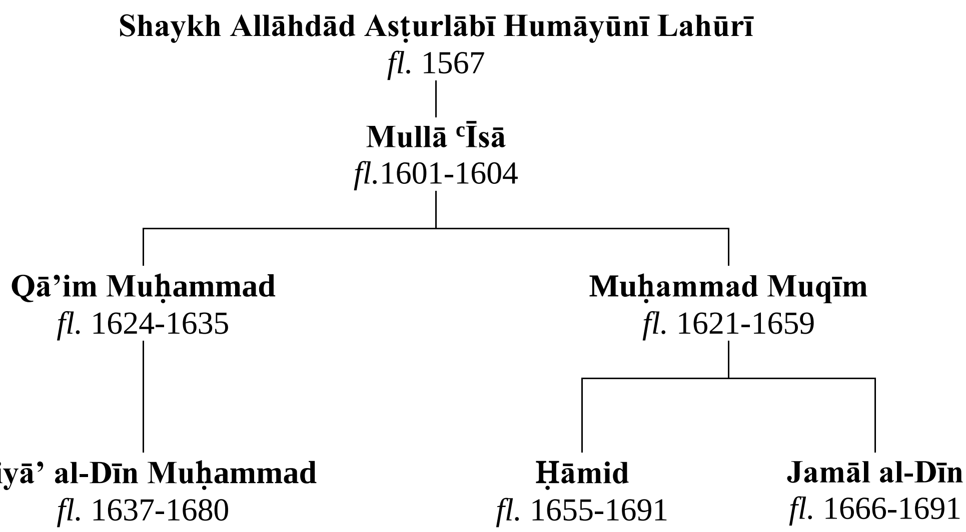
88 Abū al-Faḍl 1, pp. pp. 283-284.

89 Abū al-Faḍl 1, p. 52, states that Mawlānā Maqṣūd of Herat, who was at the court of Humāyūn, made astrolabes and globes which were much admired by people. But none of his instruments survived.

90 Sarma 1994d.

is reconstructed entirely from the signatures of their dated instruments. The credit for discovering the family goes to Sayyid Sulayman Nadvi.[91]

There exist two astrolabes bearing the name of the patriarch Allāhdād (*fl.* 1567). One of these also carries the year of manufacture as 975 Hijrī (AD 1567/58). This is in fact the earliest extant astrolabe produced in India. Allāhdād's son ᶜĪsā (*fl.* 1601-1604) is known through three astrolabes. ᶜĪsā had two sons, Qā'im Muḥammad (*fl.*1624-1635) and Muḥammad Muqīm (*fl.*1621-1659). Four astrolabes and four celestial globes signed by Qā'im Muḥammad survive. Qā'im's younger brother Muqīm and Qā'im's son Ḍiyā' al-Dīn Muḥammad (*fl.*1637-1680) were very prolific instrument makers. While at least thirty-three astrolabes and one celestial globe crafted by Muḥammad Muqīm are extant in different collections throughout the world, his nephew Ḍiyā' al-Dīn's signature adorns thirty-four astrolabes and eighteen celestial globes. In comparison, Muqīm's two sons, Ḥāmid (*fl.* 1655-1691) and Jamal al-Dīn (*fl.* 1666-1691) have a more modest output. Eleven astrolabes and three celestial globes by Ḥāmid are extant, while Jamāl al-Dīn is known through just four surviving astrolabes. Besides these, there are several unsigned specimens which can be attributed to this family for stylistic reasons.



It is also necessary to stress that the instruments made by them are not mass products cast in the same mould. In fact, each instrument is a unique piece as regards the size, decorations, ornaments and configuration of the various technical elements. In

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91 Sarma 1994d.

the medieval period there has been no other family anywhere, comparable to this one in the long continuous family tradition of instrument making, in the large number of instruments produced, in the artistic and technical excellence of production, or in the innovation in design.

The standard northern astrolabes produced by the members of this family distinguish themselves by the high degree of precision in the engraved stereographic projections and by the pleasing floral traceries used to connect the star pointers on the rete, with a matching design on the *kursī.* The members of this family also show a marked predilection for unusual projections invented in Andalusia in the tenth and eleventh centuries, which they incorporated in some of their standard astrolabes. These will be discussed later.

Obviously the Lahore family had a very discerning clientele among the Mughal nobility to appreciate these innovations. For these dignitaries the astrolabists fashioned highly ornate astrolabes of large dimensions, some inlaid with silver, others with gilded plates, yet others with unusual projections.

In their signatures on the astrolabes and celestial globes made by them, the members of the family refer to themselves proudly as the descendants of Allāhdād Lāhūrī Asṭurlābī Humāyūnī, 'Allāhdād of Lahore, astrolabe maker to the Emperor Humāyūn'. The only dated astrolabe by Allāhdād, the patriarch of the family, was produced in 1567, i.e., eleven years after Humāyūn's death, but that does not preclude the possibility of his producing astrolabes in Humāyūn's lifetime for the use of the emperor. The two extant astrolabes by Allāhdād (A001 and A002) are fairly large instruments in which the prime vertical, the oblique horizon, and the curves for equal hours as counted from the western and eastern horizons are inlaid with silver on all the latitude plates. Surely these astrolabes were not meant for common astrologers/astronomers, but for men of rank.

Qā'im Muḥammad is said to have begun the casting of celestial globes in one single hollow piece by *cire perdue* method. He made one such celestial globe in the eighteenth regnal year of Jahāngīr (1622) for Nawāb Iᶜtiqād Khān, brother of Nūr Jahān

Begum, the consort of Jahāngīr.[92] He also fashioned a fabulous astrolabe in 1627 for Nawāb Khwajā Abū al-Ḥasan, a high dignitary at the court of Jahāngīr. Just the rete of this astrolabe survives at Patna: in this unique rete the star pointers are joined not by the usual floral tracery but by a calligraphic design which mentions the year of production in Jahāngīr's regnal years and in Hijrī years and the name of the dedicatee (A011).

Ḍiyā' al-Dīn also fabricated unusual instruments for high nobility. In 1679, he made a celestial globe for Emperor Aurangzeb; here the outlines of the constellations figures are cut out in such way that, when the globe is lit from inside, they would appear as silhouettes. Star positions are marked with tiny holes so that they would sparkle when the globe is lit from inside.[93] In the following year he made a huge *Zarqālī* universal astrolabe for Nawāb Iftikhār Khān, the Fauzdār of Jaunpur (A091).

Such royal patronage clearly promoted the production of very large astrolabes with lavish ornamentation and technical virtuosity. The astrolabes of this Lahore family are masterpieces of Mughal metal-craft and scientific instrumentation. In the astrolabes by Muqīm and Ḍiyā' al-Dīn which are now preserved in the Salar Jung Museum at Hyderabad and in Jai Sigh's Observatory at Jaipur, the latitude plates look as if they were gilded or rubbed with gold dust. At my request, Mr. C. P. Unniyal, the chemist of the Salar Jung Museum, examined the Mughal astrolabes at his museum. He writes: 'The inner parts, which remained unexposed, clearly show remnants of surface gilding effect. This has been produced by smearing gold powder over the bronze or brass surface to enrich the surface looking like golden rather than true gilding.'[94]

It is quite likely that this activity of producing highly ornate astrolabes in Mughal India influenced the revival of astrolabe making in Safavid Persia, in the seventeenth and eighteenth centuries.[95]

Around 2004, Brian Newbury made a metallographic analysis of eight Lahore astrolabes from the Adler Planetarium, Chicago, by applying a new non-destructive

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92 The globe is in the Stonyhurst College Library, Lancashire, UK; see Savage-Smith 1985, catalogue no. 11, p. 224, Figure 12 on p. 37.

93 Savage-Smith 1985, catalogue no. 30, pp. 232-33, Figure 17 on p. 42.

94 Unniyal 1994-95.

95 Maddison 1963, p. 26.

technique of high-energy synchrotron x-ray analysis.[96] Since this technique can be applied only to two-dimensional flat objects, only the maters, retes and plates of the astrolabes were examined.

The analysis revealed that some of these parts have a higher content of zinc than the brass produced by traditional methods.[97] The brass used for these parts (referred to as $\alpha + \beta$ alloy) must have been produced by co-melting copper and metallic zinc. The high percentage of zinc facilitates the fabrication of thin metal sheets from thicker ones by repeated hammering, but without frequent heating. Metallic zinc was produced in Zawar in Rajasthan from the thirteenth century onwards; these astrolabes provide the first datable evidence for brass production by direct alloying of copper and zinc, a process which was unknown in Europe until the nineteenth century.

2. Components of the Astrolabe

Now we describe the various components of the astrolabe and, while doing so, draw attention to the special characteristics of the Lahore astrolabes. The *Sīrat-i Fīrūz Shāhī,* an anonymous chronicle composed at the court of Fīrūz Shāh Tughluq in 1370 states that the astrolabe consists of twelve components: ring (*ḥalqa*), shackle (*ᶜurwa*), rivet (*mismār*), throne (*kursī*), mater (*umm*), rim *(ḥajra*), plates (*ṣafāʾiḥ*), rete (*ᶜankabūt*), alidade (*al-ᶜiḍāda*), pin (*quṭb*), sighting plates (*libna*) and horse-shaped wedge (*faras*).[98]

2.1. The Suspension Apparatus

The main component of the astrolabe is a heavy circular plate with a raised rim all around on one side. In the recess formed by the rim, the heavy plate carries a series of circular discs, just as the mother carries the child in her womb. Therefore, this heavy plate is called *umm* in Arabic and 'mater' in Latin and in English. For observation, the mater has to be suspended vertically and, to sight the desired heavenly body, it has to

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96 Cf. Newbury 2006. Two of the these are by ᶜĪsā (A005and A006) and the rest by, or attributable to, Ḍiyā' al-Dīn Muḥammad (A059, A061, A077, A086, A096and A104).

97 The results of the analysis are given in Table 2 (Newbury 2006, p. 210). They show that in these 8 astrolabes, 4 maters are made of $\alpha + \beta$ alloy and 4 are not; 5 retes are made of $\alpha + \beta$ alloy and 4 are not. In A096 and A104, some plates are made of $\alpha + \beta$ alloy, whereas in the rest of the six astrolabes, all the plates are made of this alloy.

98 Sarma 2000.

be turned around the vertical axis. For this purpose, the mater requires a suitable suspension apparatus, consisting of a suspension bracket, a shackle and a ring. The suspension bracket, usually of a triangular shape, is attached to the top of the mater. Generally, the mater and the suspension bracket are cast together as one piece. In some early Islamic astrolabes, the throne verse (*āyat al-kursī*) from the *Qur'ān* (Surah 2:255) is engraved on the suspension bracket, which reads: 'His throne extends over the heavens and the earth'. Therefore, the suspension bracket is called *kursī,* or throne. To the top of the *kursī* is attached a shackle (*ᶜurwa*) which has a shape like the upturned Roman character U, with a circular upper part and two straight legs. The ends of the legs or bases are firmly affixed to the top of the *kursī* by means of a rivet (*mismār*). A ring (*ḥalqa*) passes through the shackle. The astronomer pushes his thumb through the ring and lets the astrolabe hang freely. Sometimes, a silken cord (*ᶜilaqa*) is also attached to the ring.

This suspensory apparatus allows the instrument to be suspended so that it remains perfectly vertical and can be swung in a circle about its axis, which is perpendicular to the local horizon. This ensures that the east-west line drawn on the back of the astrolabe and also on the plates remains parallel to the local horizon. In Lahore astrolabes, the shackle has invariably a trifoliate shape; this ensures that the ring remains always in the upper loop of the shackle.

Figure A1 – Trifoliate shackle, openwork *kursī,* lobed profiles
in an undated astrolabe by Allāhdād (A002) (photo by S. R. Sarma)

The *kursī* is relatively high and its two profiles are formed by a series of ogees and lobes with a trifoliate finial.

Figure A2 – Trifoliate finial, solid *kursī* with decorative engravings on the surface in an undated astrolabe by Muqīm (A036) (photo courtesy Dr Naseem Naqvi)

The body of the *kursī* is generally cut *à jour* in an artistic floral pattern. Muqīm likes to fashion his *kursīs* with a series of bell-shaped flowers, or tulips, with two flared petals, one petal long and another short, in such a way that the edges of the petals form the profiles of the *kursī.* Sometimes, the surface on both sides is engraved with decorative lines. Occasionally, cartouches are incorporated in the middle of the *kursīs,* for writing the names of the owners. No other inscriptions are engraved on the *kursīs.*

2.2. Limb

The upraised rim on the mater is called *ḥajra* or limb. The surface of the rim is graduated for 360 degrees of the circle and numbered in a clockwise direction in *abjad* notation, starting from the south point. The south point is situated at the top of the rim just below the throne. With regard to the points of the compass, it must be noted that the Arabs followed a convention that is quite opposite to that in modern maps. In Arabic maps, and also in astrolabes, the point at the top represents south and the point to the proper right is the east.

In Lahore astrolabes, the degree scale consists of two concentric rings. The narrow inner ring is divided in single degrees of arc. In the wider outer ring, groups of 5° or 6° and numbered in *abjad* notation. Numbering in 5s or 6s begins at the south point and proceeds clockwise. The numbering can be continuous from 5 or 6 up to 360; in some astrolabes, the numbering is done separately in each quadrant, starting from 5 or 6 and reaching clockwise up to 90.

2.3. Rete

Of the plates stacked in the hollow space inside the rim, the uppermost one is called rete or spider (*ᶜankabūt*). It is a perforated or openwork plate containing the ecliptic, the equator and the tropics of Capricorn and Cancer. Against the projection of these circles, there is a star map with pointers (*shaẓiya,* plural *shaẓāyā*) indicating the positions of some bright stars situated close to the ecliptic on the north and the south.

The rete consists primarily of two rings, a peripheral ring which contains the circle of the Tropic of Capricorn and the zodiac or ecliptic ring placed inside off centre. The ecliptic ring is represented completely, but the upper portion of the outer ring is cut off, leaving open the two ends to the east and west of the ecliptic ring. These two rings are held together by an east-west bar and south-north bar, which carry the lines of the equinoctial colure and the solsitial colure respectively. For the sake of balance, so that the rete remains steady at any given position, the two bars are designed with counter changes. Other circles like the celestial equator and the Tropic of Cancer may be represented partially on segments of rings or not at all. To the north and south of the ecliptic ring, the positions of certain bright stars are marked and these points are joined to the mainframe by different forms of supports. Leaving out these rings and straight bars, the rest of the plate is cut off so that the markings on the plate lying beneath the rete can be read.

In the ecliptic ring, the outer rim constitutes the circle of the ecliptic which is the apparent path of the sun through the year. The ring is divided into the twelve signs of the zodiac, and the names of the twelve signs (*al-Ḥamal, al-Thawr, al-Jawzā', al-Saraṭān, al-Asad, al-Sunbula, al-Mīzān, al-ᶜAqrab, al-Qaws, al-Jadī, al-Dalw* and *al-Ḥūt*) are engraved on each division, starting from the vernal equinox (situated at the intersection of the equinoctial colure and the ecliptic circle in the east) and proceeding in an anticlockwise direction. Again each sign is divided into groups of 6 or 5 degrees. The outer rim is divided into single degrees. To the first point of Capricorn is attached a small pointer which aligns the ecliptic ring to the degree scale on the limb. This pointer

is called *al-mūrī r'as al-Jadī* or simply *al-mūrī.* This may be called in Capricorn index in English.[99]

A knob (*mudīr*) is affixed at some point on the outer ring to rotate the rete to the desired position. By rotating the rete, one can see the stars rising above the eastern horizon, culminating on the meridian or setting below the western horizon.

The manner in which the star pointers are shaped and joined to the main frame is determined by the artistic inclinations of the astrolabe maker, who exhibits his artistic skills in fashioning the throne and the rete. In the Mughal astrolabes the star pointers are joined by floral traceries. A common motif is a bell-shaped flower with two flared petals, the tip of the longer petal representing the star position. This motif occurs already in the undated astrolabe by Allāhdād (A002) and is copied by his descendants in innumerable variations. These flower- or leaf-shaped star pointers and their tendrils are arranged in multiple varieties of traceries, but care is always taken to see that the tracery is almost symmetric on both sides of the meridian, so that the rete is evenly balanced in weight. The names of the stars are engraved on the leaves or flowers containing the star pointers. Since the Lahore astrolabists enjoy complex constructions, they fill the retes with dozens of stars, although few would have sufficed for actual observation.

The **star names** are in Arabic. While engraving these names, the Lahore astrolabe makers do not quite adhere to the proper usage. Because of the limited space available for engraving, or even otherwise, the Arabic definite article *al-* is often omitted. The term *ra's* (head) is usually transcribed as *rās*; thus the prominent star Algol (β Persei) which occurs in almost every astrolabe is labelled as *rās al-ghūl* instead of *ra's al-ghūl.* Epithets in masculine gender are added to feminine nouns; thus the stars α and β in the constellation Libra are labelled respectively as *Kiffa Janūbī* and *Kiffa Shamālī* and not as *Kiffa Janūbiya* and *Kiffa Shamaᶜāliya* with feminine epithets; likewise ε Cancri is named *Nathra Saḥābī.* Finally, Procyon carries the label *Shiᶜrā al-Shāmī* and not *Shiᶜrā al-Shaᶜāmiya.* However, in order to retain the peculiarity of the usage, the engravings are transliterated exactly, without making any attempt at assimilation or vocalization.

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99 Turner 2015.

2.4. Plates

Beneath the rete are housed a series of plates, also called tympans, discs or tablets (singular *ṣafīḥa;* plural *ṣafāᶜiḥ*), which are specific to certain terrestrial latitudes.[100] While the rete represents the stellar heavens, the plates represent the earth at different latitudes. Together, they simulate the stars above a particular terrestrial latitude at a given time.

While the rete in the front and the alidade at the back must be free to rotate around the centre, the plates must stay firmly in position inside the rim of the mater. For this purpose, each plate is provided with a projecting tab, which fits into a slot cut into the thickness of the rim. This system is reversed in the astrolabes produced in India. In Indian astrolabes, the rim has the projecting tab at the north point which fits into the slot cut in the plates at the corresponding place.

2.4.1. Latitude Plates

The projection on the plates varies according to the terrestrial latitude of the place where the astrolabe is used. Therefore, several plates are made with projections suitable to different latitudes, so that the astrolabes can be used at different places, usually from Mecca to Samarqand. On these plates are drawn, as on the rete, concentric circles to represent the Tropic of Capricorn (*madār al-jadī*), the tropical equator (*madār al-ḥamal wa al-mīzān*) and the Tropic of Cancer (*madār al-saraṭān*), and the vertical and horizontal diameters. The horizontal diameter represents the horizon at the equator. These circles and the lines are common to all the latitude plates.

Then on each plate are traced, relative to its latitude, stereographic projections of the local or oblique horizon (*ufq,* or *ufq al-mashriq wa al-maghrib*), equal altitude circles, azimuth arcs, lines for seasonal hours, lines for equal hours, and so on. The point where the horizontal diameter, the oblique horizon and the equator intersect in the east is designated as the east point (*nuqṭat al-mashriq*) and the corresponding point on the west the west point (*nuqṭat al-maghrib*). On astrolabes, these two points are labelled respectively as *al-mashriq* and *al-maghrib.*

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100 On the plates, see Hartner 1968, 293-299; Morrison 2007, pp. 58-63; 67-94.

The **equal altitude circles** or almucantars (*al-dā'ira al-muqanṭara*) are circles parallel to the local horizon drawn from the horizon up to the zenith (from Arabic *samt al-ra's,* 'the direction of the head'). The intervals at which these circles are drawn depends on the size of the astrolabe. On very large astrolabes, they are drawn for every degree; on smaller ones at intervals of 2°, 3°, 5° or 6°. Astrolabes are classified according to the number of altitude circles. Astrolabes with 90 circles drawn for every degree are called complete, perfect or solipartite (*tāmm*), those with 45 circles at intervals of 2° are called bipartite (*niṣfī*), with 30 circles at intervals 3° tripartite (*thulthī*), with 18 circles at intervals of 5° quinquepartite (*khumsī*), and with 15 circles at intervals of 6° sexpartite (*sudsī*).[101] The altitude circles are numbered on both sides of the meridian, so that it becomes easy to read them when the sun or the star is on the eastern or in the western horizon.

In a few astrolabe plates twilight or crepuscular arcs are drawn at 18° below the oblique horizon to help in determining Islamic prayer times.

Equal **azimuth circles** (from *al-sumūt,* plural of *samt,* 'direction') are the great circles passing through the zenith and the nadir; when projected on the astrolabe plate, they radiate from the zenith at appropriate intervals depending on the size of the astrolabe. On some plates, these are drawn above the local horizon, on some below the local horizon, and on others both above and below the horizon. These are also drawn at appropriate intervals depending on the size of the astrolabe. These are numbered from the east and west points up to the north and south points. From the observer's point of view, the altitude circles and the azimuth arcs are mutually perpendicular and the grid formed by them can be used to define the position of a star.

Lines for the seasonal and equal hours are drawn below the local horizon, in the space between the two tropics. **Seasonal or unequal hours** (*al-sā^cāt al-zamāniya*) are the twelfth parts of day or of the night and vary from season to season. In the Middle Ages time was reckoned, in the daily life and in religious rituals, in these seasonal hours both in the Islamic world and in Christian Europe. These are counted from the sunset at night and from the sunrise in the day; in the Islamic world the day (i.e. the combined

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101 Hartner 1968, p. 296.

unit of day and night) is counted from the sunset. The lines for the seasonal hours are drawn by dividing the arcs of the two tropics and the arc of the equator lying below the oblique horizon into 12 equal parts and by joining the corresponding points in the three arcs. These are numbered from the western horizon to the eastern horizon from 1 to 12 and serve for counting the hours both at night and in the day.

Equal hours (*al-sā*c*āt al-i*c*tidāl*) are the twenty-fourth parts of the day and night and were used for astronomical purposes. These are constructed by dividing the complete circles of the two tropics and of the equator into 24 equal parts, starting from the point of intersection with the western horizon, and by joining the corresponding points in the three circles. Occasionally the equal hour lines are drawn from the western as well as from the eastern horizon. The lines of the unequal hours and the lines of the equal hours intersect at the equator. Generally the lines of the equal hours are drawn as dotted lines to distinguish them from the lines of unequal hours.

In the space between the oblique horizon and the lower part of the Tropic of Cancer are engraved, on either side of the vertical diameter, the latitude (*al-*c*arḍ*) for which the plate is calibrated and the maximum duration of the daylight hours (*al-sā'āt*) at that latitude. These values are also recorded in *abjad* notation. However, on several Lahore astrolabes care is not taken in recording the correct values of the daylight hours.[102]

In about a dozen astrolabes by Qā'im Muḥammad, Muqīm and Ḍiyā al-Dīn, **lines for *ghaṭīs*** of 24 minutes are also drawn in addition to the lines for equal and unequal hours, *Ghaṭīs* are traditional units of time in India and the Muslim rulers and common citizens of India adopted them for their secular activities. These are equal units; two and a half *ghaṭīs* make one equal hour. Therefore on some large astrolabes, the lower half of certain plates is cluttered with lines for unequal hours, equal hours and *ghaṭīs*. Usually these lines are drawn on the plates for the latitudes of the three Mughal Imperial cities,

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[102] Sometimes just the hours are engraved without the minutes; many times the recorded values of hours and minutes are not correct. Such cases occur often in astrolabes made by Muqīm, e.g., A023, A024, A026, A029, A031 and so on. Ḍiyā' al-Dīn's astrolabes are generally free of this defect; the only cases noticed are in A095, A099, A100 and A101 which are not signed by Ḍiyā' al-Dīn, but are attributed to him. Ḥāmid's astrolabes are also free of this defect; in fact, he mentions the maximum duration in hours, minutes and seconds. Of astrolabes by Jamāl al-Dīn, information is available only of A121; here the maximum duration is mentioned only in hours.

namely Agra at 27°, Delhi at 29° and Lahore at 32°, but sometimes, other plates are also engraved with such lines (for example, in A051 and A096). Moreover, in the middle of some plates, the duration of the longest day is also expressed in *ghaṭīs* (spelt there as *karīhā*).[103] Strangely in almost all cases, the *ghaṭī* values do not match with the values in hours. This is inexplicable because hours and *ghaṭīs* are in a simple ratio of 60 : 24 or 5 :2.[104]

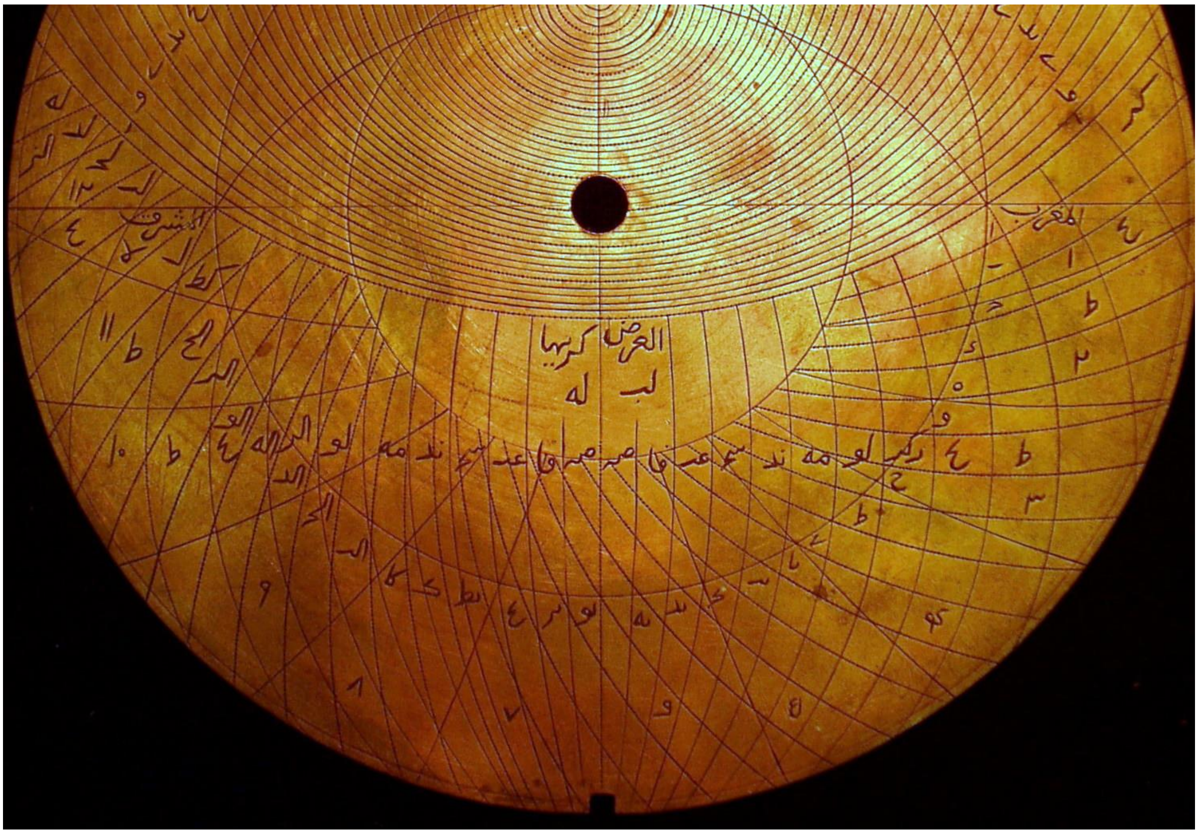

Figure A3 – Plate for 32° in astrolabe A014 by Qā'im Muḥammad (photo S. R. Sarma).

In Fig. A3 above, the *ghaṭī* lines are dotted;and numbered in *abjad* from the western horizon, from 1 to 35, below the circle of equator. Plain lines are for seasonal hours; these are numbered in common Arabic/Persian numerals, from 1 to 12, close to the periphery. In the middle of the plate is written *al-ᶜarḍ 32* and *karīhā 35* (latitude 32, *ghaṭīs* 35). In other astrolabes, the duration of the longest day at latitude 32°, is given consistently as 14;8 hours; this is equivalent to 35;20 *ghaṭīs* and not just 35 to *ghaṭīs.*

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[103] These astrolabes are A014, A015, A051, A064, A067, A072, A096, A104 and A112.

[104] Equally inexplicable is that in Sanskrit astrolabes also, as will be shown in section C, the *ghaṭī* values and the values in hours for the maximum duration of the daylight rarely match.

2.4.2. Tablet of Ecliptic Coordinates

Besides the plates designed for specific terrestrial latitudes, the Lahore astrolabes invariably contain a plate the two sides of which are designated respectively as *ṣafīḥat mīzān al-ᶜankabūt* (tablet of the ecliptic coordinates) and *ṣafīḥa al-āfāqiya* (tablet of horizons). Both occur for the first time in al-Khujandī's astrolabe of 984.

The tablet of ecliptic coordinates is basically a plate made for the arctic circle at the latitude of 90° diminished by the obliquity of ecliptic. Al-Khujandī determined the obliquity as 23;33°. Accordingly, he calibrated the plate for the latitude of 66;27°. The Lahore astrolabe makers use the approximate value of 23;30° for the obliquity and design the plates for latitude 66;30°. At this latitude, the ecliptic coincides with the horizon and the ecliptic pole with the zenith. The altitude circles run parallel to the ecliptic and azimuth arcs radiate from the zenith, dividing the ecliptic circle perpendicularly at regular intervals.

Thus, the astrolabic markings on this plate correspond to an ecliptic coordinate system. When the rete is placed on this plate, the ecliptic latitudes and longitudes of the stars represented on the rete can be read directly from the altitude circles and azimuth arcs respectively. Therefore, this plate is called *ṣafīḥat mīzān al-ᶜankabūt*, 'the plate of the balance or measure of the rete'. This plate can be used for converting the coordinates from the ecliptic system to the equatorial system and vice versa.

2.4.3. Tablet of Horizons

The reverse side of the tablet of ecliptic coordinates is designed as the tablet of horizons (*ṣafīḥa al-āfāqiya*). It was originally invented by Ḥabash al-Ḥāsib at Baghdad in the ninth century. On this plate are engraved horizons (*ufq,* plural *āfāq*) for several latitudes, many more than those which are available on the other plates. These horizons are useful in solving problems relating to sunrise and sunset, the length of the day and the rising times of stars without requiring a separate plate for each latitude. If complete horizons for all degrees are engraved, the plate would be cluttered. Therefore, half horizons for latitudes up to 66°, at convenient intervals, are arranged in four sets in the four quadrants of the plate. The latitude for each horizon is marked where it begins near the circumference and where it ends near one of the diameters. Along the four radii are drawn graduated declinations scales, between the equator and the tropics, and the last cells of these scales are marked with the value of the maximum declination or the

obliquity of the ecliptic. The scales to the south of the ecliptic carry the label *mayl kullī janūbī* (maximum declination south) and those to the north the label *mayl kullī shamālī* (maximum declination north).

For making use of any of the horizons drawn in one of the four quadrants, the plate should be so placed inside the astrolabe that the east point of the horizon coincides with the east point of the astrolabes. Therefore, notches have to be cut at the four points of the compass on the plate, so that the plug affixed inside the rim at the north point fits into each of the four notches on the plate. But these plates in the Lahore astrolabes rarely have four notches; they have just one notch at the north point. Thus these plates merely serve didactic purposes.

In the astrolabes produced in the Maghreb, the half-horizons are arranged on the plate, not in four sets, but in eight sets. The horizon plate in the undated astrolabe by Allāhdād (A002) is designed in this manner (see Figure A002.4). The horizon plates in all other Lahore astrolabes carry half-horizons in four sets.

2.4.4. Plates with astrological houses

A very small number of astrolabes, in particular those with *zawraqī* horizons on the rete, are equipped with plates on which the astrological houses are marked. The lines that divide the houses pass through the point of intersection of the oblique horizon and the meridian.[105] On some of these plates the houses are numbered with ordinals (starting at the eastern horizon and proceeding counterclockwise): *ṭāli^{c}, thānī, thālith, rābi^{c}, khāmis, sādis, sābi^{c}, thāmin, tāsi^{c}, ^{c}āshir, ḥādī ^{c}ashar* and *thānī ^{c}ashar.*

2.4.5. Double Projection for latitudes 0° and 90°

On one of the plates in his astrolabe, al-Khujandī draws, for the first time, projections for latitudes 0° (equator) and 90° (north pole). The horizon at the equator is represented by the horizontal diameter of the plate. The zenith and nadir lie on the circle of equator. The altitude circles parallel the horizon are drawn as arcs of the circle. As they go higher, they become full circles around the zenith. Azimuth circles are drawn

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105 Kaye 1918, p. 19, n. 4.

as arcs radiating from the zenith. This plate is useful for solving problems related to rising times.

The lower half of the plate carries the projections for latitude 90° (North Pole). Here the horizon coincides with the equator; the altitude circles merge with the declination circles and the azimuth circles with the hour lines.[106]

Because of its didactic value, this double projection of latitudes 0° and 90° is emulated in many Lahore astrolabes, starting from the astrolabe of 1604 by ᶜĪsā (A006). This plate should actually have notches at the north and south points so that both halves can be made use of, but the plates in the Lahore astrolabes have just one notch at the north point like the rest of the plates.

The Lahore astrolabes exhibit double projections of other pairs of latitudes also such as latitudes 18° and 72° and so on. In such double projections, the altitude circles of one latitude are ingeniously extended as the latitude circles of the second latitude, creating an interesting pattern like the Roman letter S.

There are also plates with triple projections. A frequently represented combination is for latitude 0° in the upper half and for latitudes 72° and 90° in the lower half. This projection also appears for the first time in the astrolabe attributed to ᶜĪsā (A008). These plates display the virtuosity of the engraver.

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106 Morrison 2007, Fig. 4-10, p. 65: 'The plate for equator is useful for solving problems common in the study of the history of astronomy involving rising times (i.e., elapsed time for a specific number of ecliptic degrees to rise). The horizon at the equator is called "sphaera recta". The horizon at other latitudes is called "ascensio recta" or "right ascension". The astrolabe was commonly used to solve these problems before the development of spherical trigonometry.
'The plate for the North PoleMorrison 2007 shows declination directly. At the North Pole the horizon is the equator and declinations of anything on the rete can be read directly from this plate. Negative declinations cannot actually be seen from the North Pole but [on] the plate divisions extend up to the Tropic of Capricorn. The azimuth arcs correspond to hour angles of the sun or a star. If the rete is set to 0 hr sidereal time, the azimuth arcs correspond to the right ascension of any point on the rete. Another use of the plate for the North Pole is to locate planets or other objects not included on the rete.'

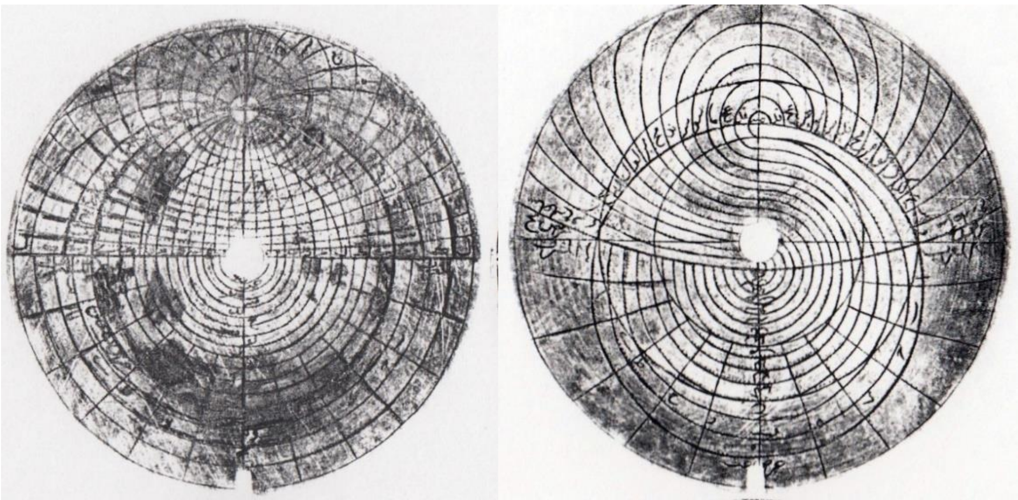

Figure A4 – Double projection of latitudes 0° and 90° on the left;
triple projection of latitudes 0°, 72° and 90° on the right; astrolabe attributable to ᶜĪsā (A008).

2.5. Geographical Gazetteer

The inner side of the astrolabe may contain, like the two sides of the latitude plates, projections for one more latitude or a geographical gazetteer with terrestrial coordinates for certain localities. The geographical gazetteer is not really essential for using the astrolabe; it is added just as a memorandum. One can also consult a manuscript for the information provided by the gazetteer on the astrolabe. But presumably, the astronomers and astrologers desired that the astrolabes contain all the necessary astronomical, astrological and geographical information at one place, as in the smart phones today.

The earliest astrolabe to have a gazetteer is one made by Nasṭūlus around 927; of this astrolabe only the mater survives with a small gazetteer engraved on the front and trigonometric quadrants on the back.[107]

2.5.1. Parameters in the Gazetteers

The gazetteers in Islamic astrolabes usually provide five parameters: (i) longitude (*ṭūl*), (ii) latitude (*ᶜarḍ*), (iii) *inḥirāf,* (iv) *jihat* and (v) *masāfat*. The longitudes are measured from the Fortunate Islands (*al-Jazā'ir al-Khālidāt*) in the Atlantic, roughly 35° west of Greenwich. The latitudes are well known, they are measured from the equator up to the north pole or up to the south pole. In his path-breaking *Description of*

[107] King 2008, p. 97.

the Persian Astrolabe constructed for Shah Husain Safavi, William Morley explains the last three parameters thus:

> The Inhiráf is an arc of the horizon, intercepted between the meridian of any place and a vertical circle passing through the zenith of such place and that of Makkah, such circle being called the Azimuth of Kiblah; and it is equal to the angle at the zenith of such place, formed by the said meridian and vertical circle, which is measured by the forementioned arc. This angle is the Angulus positionis of our older geographers. The Masáfat is the distance in a straight line, as the crow flies, between any place and Makkah, i.e., it is the arc of the great circle intercepted between the zenith of such place and that of Makkah in the nearest direction; the distance is computed in Fasangs, Miles, or Barids, بريد *posts* (Veredus). The Jihat is the direction of the Azimuth of the Kiblah with reference to any place and the four cardinal points; and it denotes the quarter of the horizon of such place in which Makkah is situated. It is obvious if the Inḥiráf, the Masáfat, and the Jihat, are known at any place, the position of Makkah, with regard to such place, is completely defined. If the place be of the same latitude as Makkah, there is no Inḥiráf; of the same longitude, the Inḥráf is 90°: in either case, the Masáfat and Jihat are sufficient to determine the position of Makkah.[108]

Indo-Persian astrolabes carry a geographical gazetteer on the inner side of the mater and not projections for a latitude. Allāhdād, in the very first extant astrolabe of 1567 (A001), set out to provide the longitude, latitude and *inḥirāf,* and drew five columns on the inner side of the mater for the names of the localities (*al-bilād*), longitude (*al-ṭūl*), latitude (*al-ᶜarḍ*), orientation towards Mecca (*inḥirāf*) and the duration of the longest day (*al-sāᶜāt*), but left, for no discernable reason, the last two columns blank. Surely he must have had at his disposal some *zīj* with all these

[108] Morley 1856, p. 23.

parameters from which he had copied the names, longitudes and latitudes, but not the other two items.

He drew the same five columns in his undated astrolabe (A002), but the cell for the *inḥirāf* is often blank; sometimes it is filled by the maker, other times by a later hand in a smaller and scratchy script. Many cells of the longest days are also not filled, especially for places in the Indian subcontinent. In A003, which can attributed to Allāhdād, the gazetteer provides the latitude (*al-ᶜarḍ*), co-latitude (*tamām al-ᶜarḍ*), and longitude (*al-ṭūl*) in this order. This is perhaps the only astrolabe to list co-latitudes (90-φ), which can easily be calculated from the latitudes. In A004, which too can be attributed to Allāhdād, the following data is planned to be provided: name of the locality (*al-bilād*), longitude (*al-ṭūl*), latitude (*al-ᶜard*), *inḥirāf* (*al-inḥirāf*) and the duration of the longest day (*al-sāᶜāt*), but the cells corresponding to the last two items are left blank as in the astrolabe of 1567. This is one of the reasons for attributing this astrolabe to Allāhdād.

His descendants ᶜĪsā, Qā'im Muḥammad, Muqīm and Ḍiyā' al-Dīn give only the longitudes and latitudes. In A093 which is attributable to Ḍiyā' al-Dīn, the longest day appears once again along with the longitude and latitude.

Ḥāmid tries to make up for the omission of his ancestors and provides longitudes, latitudes, *inḥirāf* (which he calls *qibla samt*) and *jihat* in (A113, A114, A115, A116) of his eleven signed astrolabes and also in A119 which is attributable to him.

2.5.2. Sources of the Gazetteers

Obviously these gazetteers were derived from some Arabic or Persian astronomical tables (*zīj*) and similar texts. One of the important records of such geographical information in the Mughal period is the *Ā'īn-i Akbarī,* compiled by Abū al-Faḍl at the court of Akbar. It contains the longitudes and latitudes of some 656 localities arranged according to the climates.[109] I compared the gazetteer on the astrolabe of 1074/1663-64 by Ḍiyā' al-Dīn (A084) with the data in the *Ā'īn-i Akbarī,* but did not

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[109] Abū al-Faḍl 3, pp. 50-116. This gazetteer is rearranged alphabetically in Kennedy 1987a, pp. 569-580.

find much correspondence between the two gazetteers.[110] Ḍiyā' al-Dīn arranges three of his gazetteers according to the regions, starting from Maghreb in the west and reaching up to India in the east (A062, A072, A093; see especially A072). These are derived from Ulugh Beg's geographical tables.[111] Otherwise, we do not know of any other sources used in these gazetteers. However, whichever sources they may have used, the astrolabe makers do not seem to have gathered the data with some consistency from their sources, so much so the geometrical coordinates given for a city by the same astrolabe maker differ from one astrolabe to another.

For example, in Ḍiyā' al-Dīn's astrolabes, Ajmer in Rajasthan, an important centre of Muslim pilgrimage in the Mughal period (and even now) is placed consistently at longitude 111;5° in all the astrolabes, but latitude varies from 24;0° to 25;0° to 26;0°. In the case of Ahmedabad, again an important city in Mughal India, the longitude has the values of 103;40°, 108;0° and 108;40° and the latitude 23;15°, 23;55° and 28;55°. These variations can be explained away by the fact that the forms of *abjad* numbers look almost alike without the diacritical points. But no such explanation justifies the variation in the case of Iṣfahān; here the longitudes recorded are 82;40°, 85;0°, 86;40° and 87;40. The latitudes are more consistent: often 32;25°, but a few times 34;25°. This is so in the case of the astrolabes by the other members of the family as well. The only cities to have consistently uniform values are Mecca (long. 77;10° and lat. 21;40°), Medina (long. 75;20° and lat. 25;0°), and Lahore (long. 109;20° and lat. 31;50°).

2.5.3. Localities listed in the Gazetteers

While these astrolabe gazetteers seek to cover the entire area of the Islamic world, with the majority of localities enumerated being from the Greater Iran, the geographical information on the eastern and southern parts of the Indian subcontinent is very meagre. The localities usually mentioned in the east are Benares, Jaunpur and Dhākā Bangālah, i.e., Dhaka in modern Bangladesh. The southern localities mentioned are Daulatabad, Golconda (i.e., modern Hyderabad) and Bijapur. This scanty information is particularly surprising in view of the fact that the Mughal Empire extended quite far into the east

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110 Sarma 2003, pp. 43-47.

111 Sédillot 1853, pp. 257-271.

and into the south. Geographical parameters of a large number of Indian localities are compiled in Sanskrit geographical tables, [112] but the Lahore astrolabe makers do not seem to have consulted these sources.

Naturally Agra, Delhi and Lahore, the three Mughal Imperial cities, receive prominence in the Lahore astrolabes. As mentioned already, in many astrolabes there is one plate, one side of which is designed for Lahore at latitude 32° and the other side either for Agra at 27° or for Delhi at 29°. Likewise, as will be show below, on the back of the Lahore astrolabes, there are often curves for the meridian altitude of the sun at the latitudes 27°, 29° and 32°. In the astrolabe gazetteers, the three cities are invariably mentioned. Agra is referred to as Akrah, Akbarābād, Akbarābād Dār al-Khilāfat, or Akbarābād Dār al-Mulk Hind; Delhi as *Ḥaḍrat Dihlī,* Shāhjahānābād, Ḥaḍrat Shāhjahānābad, or Shāhjahānābād Dār al-Mulk Hind; and Lāhūr as Lahāwar, or Lāhūr Dār al-Salṭanat.[113]

One locality deserves special mention. Most of the astrolabe gazetteers mention 'Sarandīb' (also spelt 'Sarāndīb'), which is the Arabic name for Sri Lanka,[114] with the longitude 130° and latitude 10°. While the latitude of 10° is a reasonable approximation for the northern tip of the island, the longitude of 130° places the island far in the East on the same meridian as Dhaka.[115] This is inexplicable because the exact location of the island must have been well known to the Arab sailors.

2.5.4. Arrangement of the Gazetteers

Now some remarks are in order about how the geographical material is organized in the astrolabe gazetteers. Many gazetteers commence from the holy city of Mecca, or from Qairawān (Kairouan in modern Tunisia) and proceed in the order of increasing

112 Pingree 1996.

113 I must not forget to add that the city of Aligarh, where my wife and I spent most of our professional careers and where our son was born and grew up, is mentioned in almost all the gazetteers as 'Kūl [wa] Jalālī'. Kūl (pronounced Kol) was an old name of Aligarh, often listed with Jalālī which lies some 20 km to the east.

114 The Arabic name *Sarandīb*, which gave rise to the felicitous term 'serendipity' in English, has a close phonetic affinity to the Sanskrit *Śaraṇa-dvīpa,* 'the island of shelter', for Sri Lanka offered shelter to the ships tossed about by the fierce monsoon winds. However, the expression is not attested in any Sanskrit source.

115 Even Abū al-Faḍl 3, p. 57, has the same longitude of 130°, but the latitude there is 12°.

longitudes. Several astrolabes by Qā'im Muḥammad, Muḥammad Muqīm and Ḍiyā' al-Dīn have gazetteers organized according to climates. Classical geography divides the inhabited portion of the northern hemisphere into seven stripes called climes or climates (Arabic *iqlīm,* plural *aqālīm*) parallel to the equator so that the maximum daylight at the middle of each climate is half an hour longer than that in the preceding climate. But these gazetteers start from the equator (i.e., below the first climate) and go beyond the seventh climate. In the astrolabe of 1045/1635-36 by Qā'im (A013), he gazetteer is arranged according to climates, but commences with the second climate so that Mecca is at the beginning of the enumeration; thereafter come the first, third, fourth, fifth, sixth and seventh climates. The same is done in the astrolabe of 1031/1621-22 which is attributable to Qā'im Muḥammad (A014).

A third variety of arrangement is by regions, from the Maghreb in the west up to Hind (India south of Indus) in the east. Such arrangement occurs only in three astrolabes by Ḍiyā' al-Dīn (A062, A072 and A093).

Incidentally these arrangements by climates or regions appears to be peculiar to the Lahore astrolabes only.[116]

2.5.5. Style of Presentation

Aside from the variation in the arrangement of the localities, the gazetteers exhibit also varying styles of presentation, because the large area of the inner surface of the mater allows all kinds of stylistic experimentation. While the rows remain circular, the columns are sometimes curved, all slanting in a single direction and sometimes zigzag. The orientation of the letters also varies; in some gazetteers the upper part of the letters is oriented towards the centre and sometimes towards the outer circumference, and sometimes both in different annuli. In some gazetteers, each piece of data is enclosed in cartouches, the designs of which vary from each circle. Thus the Lahore astrolabe makers invested much technical and artistic efforts to make the gazetteers real objects of art.

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116 I checked the catalogues Pingree 2009, Gibbs & Saliba 1984, and King 1999b, but do not find such arrangements in any non-Indian astrolabe.

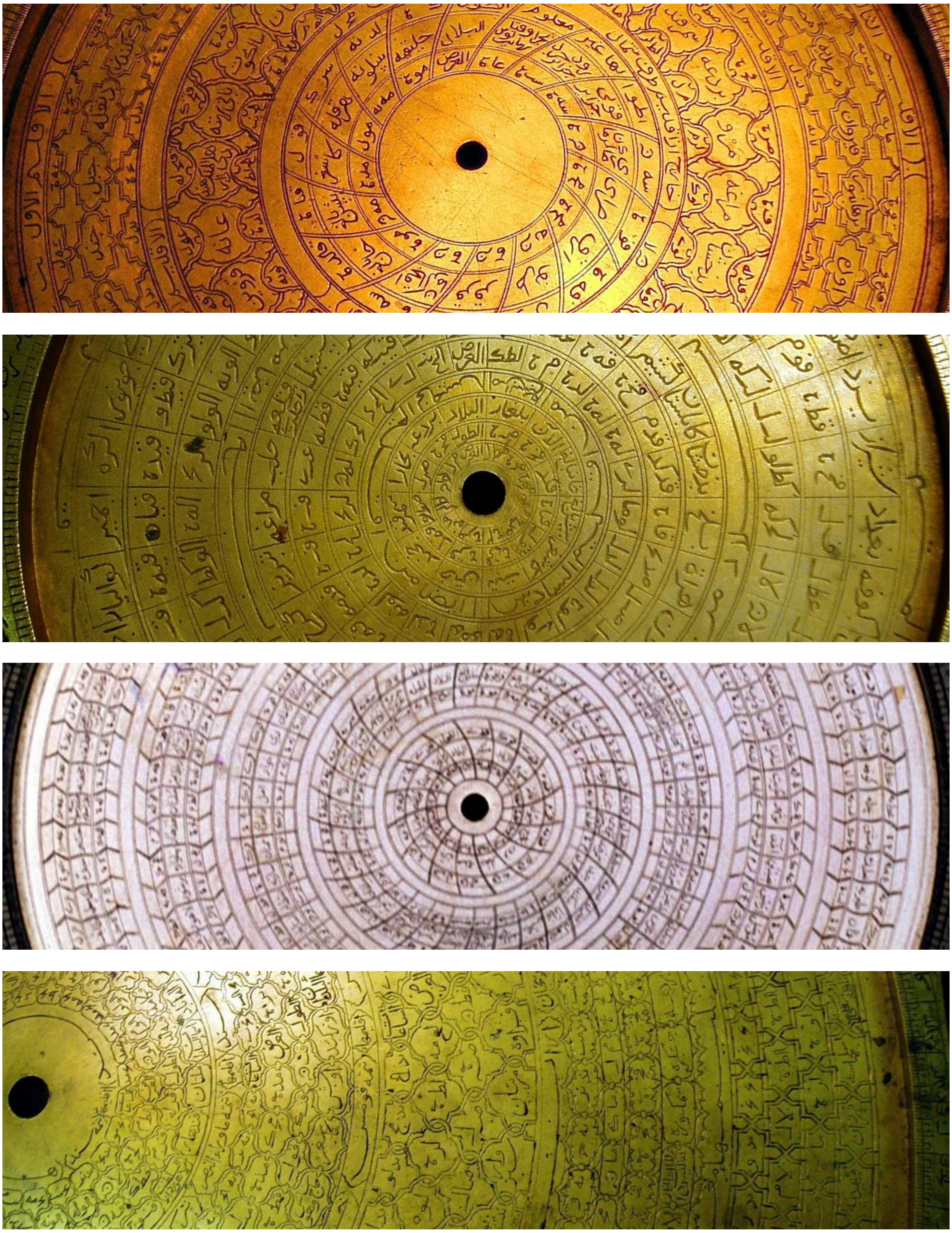

Figure A5 – Different styles of gazetteers (details of gazetteers from A014, A016, A051 and, A093)
(all photos by S. R. Sarma)

2.6. Back of the Astrolabe[117]

The back of the astrolabe (*ẓahr al-asṭurlāb*) is divided by the vertical and horizontal diameters into four quadrants which contain much trigonometric, geometric and astrological data. The rim of the two upper quadrants carries two altitude scales on which the altitudes of the heavenly bodies are measured by means of the alidade. Like the limb in the front, the altitude scales on the back also consist of two bands. The narrow inner band is graduated in single degrees. The broader outer band is divided in groups of 5° or 6°, exactly as in the front. But here these groups are numbered from 5 or 6 up to 90, starting at the east and west points and reaching the south point.

2.6.1. Trigonometric Quadrant on the Upper Left[118]

The upper left quadrant carries a sexagesimal trigonometric graph with equally spaced horizontal lines and vertical lines. In some astrolabes the vertical radius is divided into 60 equal parts, and from each point of division are drawn lines parallel to the horizontal radius up to the circumference. In others, both radii are divided in this manner and horizontal and vertical lines are drawn from each point of division. For the sake of clarity, every third or fifth line is highlighted with dots. The angle of the altitude is measured by the alidade on the altitude scale. The portion of the vertical radius intercepted by the horizontal line from the angle is the sine of the angle. Likewise, the portion of the horizontal radius intercepted by the vertical line from the angle is the cosine of the angle. Smaller astrolabes have 30 horizontal lines and 30 vertical lines.

2.6.2. Solar Quadrant on the Upper Right[119]

The upper right quadrant is designed as a solar quadrant which is a kind of yearly calendar. Here the horizontal and vertical radii are divided into six equal divisions. On these divisions are written the names of the signs or their serial numbers in the following manner. Along the vertical radius, from the centre up to the circumference, are written the names of Cancer (3), Leo (4), Virgo (5), Libra (6), Scorpio (7) and Sagittarius (8),

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117 See especially Morrison 2007, pp. 109-142 with a wealth of diagrams explaining how to draw the various projections.

118 Morrison 2007, pp. 126-132.

119 Morrison 2007, pp. 134-143.

i.e., from summer solstice to winter solstice. Along the horizontal radius are written, from the circumference up to the centre, the names of Capricorn (9), Aquarius (10), Pisces (11), Aries (0), Taurus (1) and Gemini (2), i.e. from winter solstice to summer solstice. From the points of division of the two radii, quarter circles are drawn, i.e., for every 30° of solar longitude. These are the arcs of declination. Solar quadrant shows the sun's declination for each sign of the zodiac. In larger astrolabes, arcs are drawn at smaller intervals, usually for every 10° of solar longitude, occasionally also for 6°.[120] On this solar quadrant, curves showing the sun's midday altitude (*khaṭṭ nisf al-nahār*) for each day of the year at selected latitudes are traced.[121] These curves show the relation between the sun's right ascension and the meridian altitude. ᶜĪsā introduced these curves in the Lahore astrolabes by drawing a curve for the latitude of Lahore (32°). which is the seat of his family. His son Muḥammad Muqīm usually draws two curves for 29° and 32° which are the latitudes of the two Mughal imperial cities Agra and Lahore; his nephew Ḍiyā' al-Dīn Muḥammad followed this practice on some of his astrolabes. But after Shāh Jahān shifted the Mughal capital from Agra to Delhi, Ḍiyā' al-Dīn began to add a third graph for the latitude of Delhi at 29°. Sometimes, he also drew more curves. In A096, which is attributable to Ḍiyā' al-Dīn, there are curves for as many as nine cities.

In a few astrolabes, lines showing the beginning and the end of the afternoon prayer *ᶜasr* are drawn in this quadrant. In a few other astrolabes, lines for a universal horary quadrant are drawn.

2.6.3. Shadow Squares and Cotangent Scales[122]

In the lower half, immediately below the horizontal diameter are engraved two shadow squares.[123] In Islamic astrolabes, the square to the left of the meridian is drawn for the shadows thrown by a gnomon of 7 feet (Arabic *qadam,* plural *aqdām*) and the horizontal and vertical scales are divided into 7 parts each. The vertical scale is labelled

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120 These arcs are equidistant, while in Safavid astrolabes these are drawn stereographically.

121 Cf. Kaye 1918, p. 22; Frank & Meyerhof 1925, pp. 14-15; Gunther 1932, vol. I, p. 184; Morrison 2007, pp. 136-137.

122 Morrison 2007, pp. 114-116, 132-133.

123 See Morrison 2007, pp. 114-116.

as *ẓill aqdām ma^ckūs* (umbra versa, or reverse shadow, in feet), i.e. shadow thrwn by a horizontal gnomon on a vertical plane. The horizontal scale is labelled as *ẓill aqdām mustawī* (umbra recta, or direct shadow, in feet), i.e. shadow thrwn by a vertical gnomon on a horizontal plane.

The square to the right of the meridian is drawn for the shadows thrown by a gnomon of 12 digits or fingers (Arabic (*aṣba^c,* plural *aṣābi^c*) and the horizontal and vertical scales are divided into 12 parts each. The vertical scale is labelled as *ẓill aṣābi^c* (umbra versa, or reverse shadow, in digits), i.e. shadow thrown by a horizontal gnomon on a vertical plane. The horizontal scale is labelled as *ẓill aṣābi^c mustawī* (umbra recta, or direct shadow, in digits), i.e. shadow thrown by a vertical gnomon on a horizontal plane. In some astrolabes, each division in the scales for 12 digits is further divided into 5 parts, so that the scale contains 60 parts. These scales are labelled as *ẓill sittaynī mustawī* and *ẓill sittaynī ma^ckūs.*[124]

The divisions on the horizontal scales are numbered from the centre onwards and those on the vertical scales are numbered from the top downwards. The relation of a division on the horizontal scale to the whole length of the gnomon corresponds to the cotangent and the relation of a division on the vertical scale to the whole length of the gnomon corresponds to the tangent. These shadow squares are useful in land survey for determining the heights or depths of objects and for calculating distances.

The horizontal scales on the two shadow squares are projected on the rim of the lower half to create there two cotangent scales for the bases 7 and 12 respectively.[125] The divisions are subdivided on an inner band. Muqīm labels them usually as *ẓill aqdām* and *ẓill aṣābi^c* respectively. Ḍiyā al-Dīn labels them in some of his astrolabes as *ẓill aqdām mabsūṭ* and *ẓill aṣābi^c mabsūṭ* (e.g., A062, A066 etc).

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124 See A030, A067, A072 and A092. Dr François Charette informs me that this sexagesimal scale occurs in several middle eastern astrolabes, e.g. an astrolabe dated 790 AH by Ja^cfar b Umar b Dawlatshāh (Adler Planetarium, Chicago), cf. Pingree 2009, p. 43; an astrolabe dated 830 AH and most probably dedicated to Ulugh Beg (Copenhagen, Davids Samling), cf. King 2005, pp. 761-763; an astrolabe dated 929 AH by al-Jilānī (National Maritime Museum, Greenwich). But in these astrolabes the sexagesimal scale does not carry a label.

125 Hartner 1968a, p. 302, figure 850.

The Lahore astrolabes do not strictly adhere to the arrangement of scales divided in 7 feet on the left and the scales divided in 12 digits on the right; they often reverse the order.

2.6.4. Astrological Tables

In the space inside the shadow squares and in the space between the shadow squares and the cotangent tables, several astrological tables are engraved on the Lahore astrolabes.[126] The tables engraved on the Lahore astrolabes are broadly of six types.

2.6.4.1. Correspondence between the Zodiac Signs and the Lunar Mansions

In two adjacent semi-circular rows the names of the 12 zodiac signs and those of 28 lunar mansions are written so that one can see which lunar mansions correspond to which zodiac sign. This table occurs on all Lahore astrolabes. Small astrolabes carry just this one and no other astrological table.

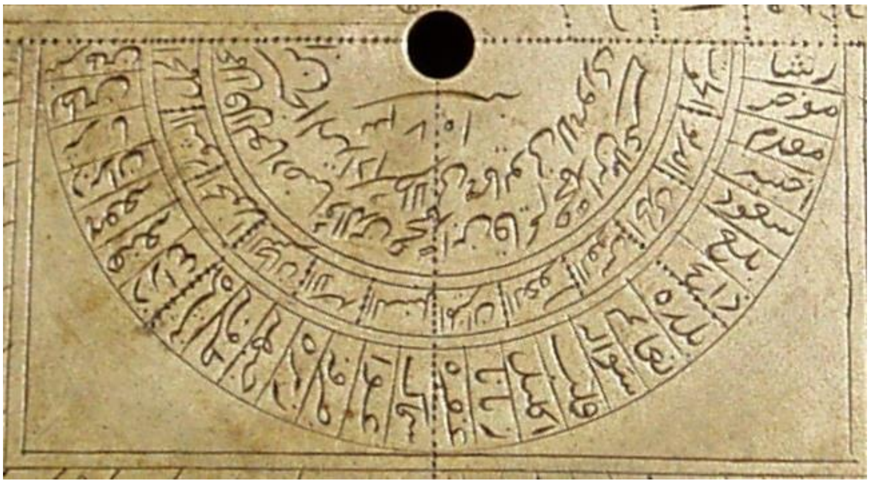

Figure A6 – Zodiac signs and lunar mansions on the back of the astrolabe A080 by Ḍiyā' al-Dīn Muḥammad (photo by S. R. Sarma)

2.6.4.2. Limits or Terms of the Signs

In this system, each zodiac sign has five intervals called *ḥudūd* ('limit' or 'term') of varying lengths which are assigned to the five planets other than the sun and the

[126] On astrological tables on the back of astrolabes, see Kaye 1918, pp. 119-126: Appendix B, Astrological Tables; Khareghat 1950, pp. 10-23; Ackermann 2005.

moon. However, the sequence of the planets and intervals assigned to them vary for each sign.[127] There are said to be several systems, but the one used frequently is derived from Egypt, hence designated as *jadwal ḥudūd misriyan.*

The intervals assigned to each planet are shown in two ways. In one the exact amount of each interval are shown in degrees of arc as in the following table on the back of an astrolabe dated 1045/1635-36 by Qā'im Muḥammad (A013).

Table A1 Limits of the Signs

Aries	Jupiter	6	Venus	6	Mercury	8	Mars	5	Saturn	5
Taurus	Venus	8	Mercury	6	Jupiter	8	Saturn	5	Mars	3
Gemini	Mercury	6	Jupiter	6	Venus	5	Mercury	7	Saturn	6
Cancer	Mars	7	Venus	6	Mercury	6	Jupiter	7	Saturn	4
Leo	Jupiter	6	Venus	5	Saturn	7	Mercury	6	Mars	6
Virgo	Mercury	7	Venus	10	Jupiter	4	Mars	7	Saturn	2
Libra	Saturn	6	Mercury	8	Jupiter	7	Venus	7	Mars	2
Scorpio	Mars	7	Venus	4	Mercury	8	Jupiter	5	Saturn	6
Sagittarius	Jupiter	12	Venus	5	Mercury	5	Saturn	4	Mars	4
Capricorn	Mercury	7	Jupiter	7	Venus	8	Saturn	4	Mars	4
Aquarius	Mercury	6	Venus	6	Jupiter	7	Mars	5	Saturn	5
Pisces	Venus	12	Jupiter	4	Mercury	3	Mars	9	Saturn	2

This shows that, of the five limits of Aries, the first is presided by Jupiter whose quantity of influence is 6, the second is presided by Venus whose influence is 6 and so on. The total influence of all the five planets is 30 degrees in each sign.

The other method is cumulative; it shows the interval assigned to a planet plus the sum of the intervals assigned to all the preceding planets. In this method, the limits of the sign Aries are displayed as follows:

Aries	Jupiter	6	Venus	12	Mercury	20	Mars	25	Saturn	30

In the tables prepared according to these two methods, as well as in all other astrological tables, the signs of the zodiac are denoted by their serial numbers and the

[127] Cf. Kaye 1918, pp. 122-123; Khareghat 1950, p. 17;

planets by the final consonant of their Arabic names. The symbols used for the planets are shown below.

Planet	**Sun**	**Moon**	**Mars**	**Mercury**	**Jupiter**	**Venus**	**Saturn**
Arabic Name	*shams*	*qamar*	*mirrikh*	*ᶜauṭārad*	*mushtarī*	*zuhrah*	*zuḥal*
Symbol	س	ر	ح	د	ی	ه	ل

2.6.4.3. Decans or Faces (*al-wujūh*) and their Regents

Decan (sing. *wujūh*; plural *wajah*) is one-third of a sign, or 10 degrees. The decans are numbered for each sign as 10, 20, 30 in *abjad* and the presiding planets are indicated by alphabetical symbols.[128]

Table A2 Decans and their Regents

Signs	***10º***	***20º***	***30º***
Aries	Mars	Sun	Venus
Taurus	Mercury	Moon	Saturn
Gemini	Jupiter	Mars	Sun
Cancer	Venus	Mercury	Moon
Leo	Saturn	Jupiter	Mars
Virgo	Sun	Venus	Mercury
Libra	Moon	Saturn	Jupiter
Scorpio	Mars	Sun	Venus
Sagittarius	Mercury	Moon	Saturn
Capricorn	Jupiter	Mars	Sun
Aquarius	Venus	Mercury	Moon
Pisces	Saturn	Jupiter	Mars

It may be noted that the sequence of planets in each column is that of weekdays.

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128 Cf. Kaye 1918, p. 123; Khareghat 1950, p. 13.

2.6.4.4. Trigons or Triplicities and their diurnal and nocturnal Regents

Trigons or Triplicities are four sets of three signs which are 120 degrees apart. These four sets are characterized as fiery (Arabic *nārī,* Persian *ātishī*), earthy (Arabic *tarābī,* Persian *khākī*), airy (Arabic *hawā'ī,* Persian *bādī*) and watery (Arabic *māhī,* Persian *ābī*) and are assigned different regents in the daytime and at night.[129] The table is entitled *arbāb muthallathāth yawmī wa laylī* , 'the regents (*rabb,* 'lord', plural *arbāb*) of the triplicities (*muthallath,* 'triangle', plural *muthallathāth*).[130]

Table A3 Triplicities and their Regents

Regents of the Trigons, diurnal					Regents of the Trigons, nocturnal			
Fiery	*Earthy*	*Airy*	*Watery*		*Fiery*	*Earthy*	*Airy*	*Watery*
Aries	Taurus	Gemini	Cancer		Aries	Taurus	Gemini	Cancer
Leo	Virgo	Libra	Scorpio		Leo	Virgo	Libra	Scorpio
Sagittarius	Capricorn	Aquarius	Pisces		Sagittarius	Capricorn	Aquarius	Pisces
Sun	Venus	Saturn	Venus		Jupiter	Moon	Mercury	Mars
Jupiter	Moon	Mercury	Mars		Sun	Venus	Saturn	Venus
Saturn	Mars	Jupiter	Moon		Saturn	Mars	Jupiter	Moon

2.6.4.5. Excess of Revolution

This table is entitled *jadwal faḍl al-dawr* (table of excess of revolution). Excess of revolution is the difference between the approximately correct length of the tropical year and 365 days which is taken to be 87;33°. The table displays the multiples of this value from 1 to 9 and then by 10s up to 90. It occurs for the first time in the astrolabes of Muqīm (A018 and others). The multipliers in the first and third columns (counted from the right) are expressed by the standard Arabic / Persian numerals, and the products in the second and fourth column in *abjad* notation.[131]

129 Persian terms are also used sometimes in these tables.

130 Khareghat 1950, pp. 19-23.

131 Cf. Kaye 1918, p. 24.

Figure A7 – Table of excess of revolution on the astrolabe of 1059/1649-50 by Ḍiyā’ al-Dīn (A062)

2.6.4.6. Climates

This table occurs in just three astrolabes by Muḥammad Muqīm with slight differences. In A024, the table is entitled *mubādī aqālīm sab*ᶜ*a* (beginnings of the seven climates) and gives the latitudes and the hours of the duration of the daylight at the beginning of the seven climates and at the end of the seventh climate. The other two astrolabes (A041 and A051) display the latitudes (*arūd*) and the hours (*sā*ᶜ*āt*) of the maximum daylight at the beginning (*mabdā’*) and the middle (*wasaṭ*) of the seven climates (*aqālīm*).

Figure A8 – Table of climates on the back of A051

2.6.4.7. Table of the Rising Times of Signs at Different Latitudes in India
(zadwal sā^c^āt ṭulū^c^ burūj bi-^c^arḍ ba^c^ḍī az bilād mulk al-hind)

This table occurs in three astrolabes by Ḍiyā' al-Dīn with slight variations. The table on A072 provides the rising times of the signs at each degree of latitude from 20° to 39°[132], A092 has a table from 20° to 40° and A093 from 21° to 40°.

2.6.4.8. Zodiac and Calendar Scales

Many European and some Islamic astrolabes contain a calendar scale together with the zodiac scale, both drawn all around inside the rim. The zodiac scale is divided into the 12 signs of the zodiac and labelled with the names of the signs. Each sign is divided into 30 degrees and numbered in 6s. The calendar scale is drawn in an eccentric circle, offset from the centre of the instrument on the line of apsides by Ptolemaic eccentricity. The circle is then divided into 365 equal divisions, which are distributed in 12 months. These two scales are necessary for determining the solar longitude of the given date, expressed in terms of the zodiac. The alidade is placed on the given date in the calendar scale and the corresponding longitude is read off from the zodiac scale. This value is used for positioning the rete on the front.[133]

Two Indo-Persian astrolabe are engraved with these scales on back. In the astrolabe made by Qā'im Muḥammad in 1045/1635 (A013), there is an eccentric calendar scale, labelled with the names of *Rūmī* (Syro-Macedonian or Byzantine) solar months, together with the number of civil days in each month. In Ḍiyā' al-Dīn Muḥammad's *Zarqālī* universal astrolabe (A091) there is a similar calendar scale, but it is concentric. All other Indo-Persian and Sanskrit astrolabes anticipate that the solar longitude is obtained from astronomical tables, either an Arabic or a Persian *zīj,* or a Sanskrit *pañcāṅga.*

2.6.5. Signature of the Astrolabe Maker

The astrolabe maker engraves his name, together with the names of his ancestors up to Allāhdād and the year of manufacture in the lower half of the back. In some

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132 This table is reproduced in Kaye 1918, p. 23.

133 Morrison 2007, pp. 111-114.

astrolabes, the space inside the shadow squares is filled by one or two rectangular tables. The signature is then engraved above these tables and below the horizontal diameter. In some other astrolabes, the space inside the shadow squares is filled by two semi-circular rows with the names of the signs and lunar mansions. The signature is placed above the two semi-circulars rows. There are also other slight variations which will be mentioned in the descriptions the corresponding astrolabes. The signature begins either with *^{c}amal* (work), or with *san^{c}at* (work), or *sana^{c}ahu* (he made). The astrolabe maker usually adds a phrase of humility before his name: *aqall al-^{c}ibād,* 'the least of the servants [of God], *aḍa^{c}f al-^{c}ibād,* 'the weakest of the servants [of God]', or *aḥqar al-^{c}ibād,* 'the most contemptible of the servants [of God]'.

Then follows the year in the Hijrī era. Sometimes the year is mentioned also in the *Rūmī* (Syro-Macedonian era) which commences from 1 October 312 BC. In a few cases the Old Persian Yazdegerd era is employed which begins on 19 June 632 AD. Occasionally the regnal years of the ruling Mughal emperor are also mentioned. While most of the astrolabes carry just the year in which the astrolabe was completed, Ḥāmid likes to mention the exact date on which a particular astrolabe was completed. Thus the very last dated astrolabe made by him was completed on 24 Ramaḍān 1102 which translates to 21 June 1691.

2.7. Alidade, Pin and Wedge[134]

On the back of the astrolabe a diopter is pivoted to the centre. This diopter, called 'alidade' from the Arabic *al-^{c}iḍāda*, is the observational part of the instrument, with which the heights or altitudes of the heavenly bodies are measured. It is a flat rectangular strip, roughly of the same length as the diameter of the astrolabe. Its two ends are tapered to sharp points. Near each end is attached a rectangular sighting plate (*libna*) at right angles to the surface of the main bar. Generally two apertures are bored in the sighting plates, one larger and the other smaller. Since the sun should not be viewed directly, the alidade is pointed towards the sun, so that the sun's ray enters the aperture in the upper sighting plate and passes through the aperture in the lower sighting plate and then falls

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[134] Some science museums offer excellent astrolabe assembling kits, together with descriptions of the components, e.g., National Maritime Museum 1976; Webster & MacAlister 1984.

on the observer's palm or on a paper. The stars can of course be viewed by placing one's eye below the lower sighting plate. Then the angle of the altitude can be read on the altitude scales in the upper left, if the sun is in the eastern hemisphere, or in the altitude scale on the upper right if the sun is in the western hemisphere. The angle then can be converted to the corresponding sine or cosine on the trigonometric quadrant.

Figure A9 – Alidade from an astrolabe by Jamāl al-Dīn (= Figure A121.7)

To facilitate this process, the two arms or halves of the alidade are engraved with appropriate scales.[135] The upper register of the right half is engraved with a sexagesimal scale numbered in 6s from the centre to the tip as 6, 12, 18 … 60 and the sloping edge is graduated in single units, so that this scale matches with the divisions of the vertical radius of the upper left quadrant. The left half of the alidade is marked with declination arcs as in the upper right quadrant on the back and labelled with the names or the serial numbers of the zodiac signs and their subdivisions.

The alidade can also be employed as a sundial by placing it in a horizontal position with the sighting plate towards the sun. Then the sighting plate on the right functions as the gnomon and throws its shadow on the surface of the alidade. A scale to measure the unequal hours from this shadow is marked on the lower register on the right hand side, numbered from 1 to 6 from the sighting plate towards the centre and from 7 to 12 in the reverse direction.

The alidades in the Lahore astrolabes have ornate ends and a matching centre piece. However, these are all straight bar alidades without any counter-change at the centre.

A large hole is bored at the centre of the centre, the plates, the mater and the alidade, through which passes a broad-headed pin to hold these parts together. The exact centre of the rete and of the plates is the celestial pole, called *quṭb* in Arabic. Since the

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135 Cf. Gibbs & Saliba 1984, pp. 57-59.

pin passes through the pole, it too is designated as *quṭb.* The pin is inserted through the holes of the components with the broad head on the back above the alidade. The other end of the pin which projects out of the assemblage in the front is pierced with a longitudinal hole through which a wedge is pushed to secure the entire ensemble.

One end of the wedge is traditionally shaped like the head of a horse from at least the time of the celebrated astrolabe made by al-Khujandī in 984. Therefore, the wedge is usually called *faras,* Arabic for 'horse'. Sometimes, washers are added in the front to make the wedge tighter.

Figure A10 – Horse from astrolabe A105

To protect the astrolabe from the vagaries of weather, it is carried in a leather pouch; or it is placed in a cloth bag and then preserved in a specially made wooden case which imitates the outlines of the astrolabe. A few such cases exist, but they may or may not be contemporary with the astrolabes they now house.

Figure A11 – Astrolabe A080 in a leather pouch (photo by S. R. Sarma)

Figure A12 – Astrolabe case, Saidia Library, Hyderabad
(photo courtesy Ahmad Athaullah)

2.8. How to use the Astrolabe

When one wishes to use the astrolabe, the first task is to place the latitude plate designed for the place of observation beneath the rete. The other plates are stacked below this plate. Then by means of the alidade at the back, the altitude of the sun is measured; or that of a bright star, if it is night. Since the Lahore astrolabes do not have a calendar scale at the back, the exact position of the sun or of the star for that moment has to be found from an almanac or from other astronomical tables. Then turning the astrolabe to the front, the rete should be rotated so that the point on the ecliptic representing the position of the sun or of the star coincides with the circle of the altitude previously measured. When the rete is thus set up on the latitude plate, these two together simulate the position of the heavens upon the observer's latitude.

Then time can be measured either in seasonal hours or in equal hours, horoscopes can be cast for that time, the auspiciousness or otherwise of the moment for any undertaking can determined and the myriad problems in spherical astronomy listed by various writers can be solved. [136]

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[136] On the use of the astrolabe, see especially Morrison 2007; Graaf 2011.

3. Non-Standard Astrolabes and Astrolabic Elements

Anthony Turner aptly remarked that 'the multiplication of complexity and a delight in the unusual seem to be typical of the astrolabe-makers of Lahore'.[137] Indeed, they show a marked predilection for unusual projections invented in Andalusia in the tenth and eleventh centuries, such as the universal plates invented by al-Zarqālluh, Ibn Bāṣo and 'Alī ibn Khalaf al-Ṣaidalānī; they were also attracted to the *zawraqī* or ship astrolabes invented by Abū Saᶜīd Sijzī, to the north-south astrolabes, to the *qibla*-indicators, and to the 'circle of visibility of Canopus' of unknown origin.

With the exception of the north-south astrolabes and *qibla*-indicators, there had been no tradition of making the other types of instruments in the immediately preceding centuries either in India or in the adjacent countries. The astrolabe makers of Lahore could not have any actual models to follow and their knowledge must have been derived entirely from Arabic treatises on these instruments.[138]

These non-standard features will be discussed here briefly; the full descriptions will be given under the relevant instruments. It may be noted that many of these non-standard features occur mainly in the astrolabes produced by Ḍiyā' al-Dīn Muḥammad.

3.1. ᶜAlī ibn Khalaf's Universal Plate

One of the major contributions of the Islamic world to the construction of the astrolabe is the universal plate that could be used at all latitudes.[139] Perhaps the first attempt in this regard was made by Ḥabash al-Ḥāsib of Baghdad when he invented the Tablet of Horizons in the early ninth century, to which reference has been made earlier in 2.4.3. But this plate is not completely universal because it cannot be used at all latitudes.

A single plate that could be used at all latitudes was developed in Toledo in the eleventh century by ᶜAlī ibn Khalaf al-Ṣaidalanī, also known as al-Shakkāz. The plate contains a vertical projection of the celestial sphere instead of the polar stereographic

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137 Turner 1985, p. 83.

138 It should be worthwhile to explore the manuscript collections in Pakistan and India, especially in Lahore, to see whether these contain any manuscript resources which may have been used by the Lahore family.

139 Turner 1985, pp. 151-166; King 2005, pp. 57-73.

projection as in the common astrolabes. The equator is represented by the vertical diameter of the plate and the ecliptic by another diameter which intersects the equator at an angle which is tantamount to the obliquity of the ecliptic. On either side of the equator and the ecliptic parallels are drawn up to their respective poles on the periphery of the plate.

This plate is accompanied by a specially designed rete. One half of this rete contains the star map as in common astrolabes, but its periphery represents the equator and not the Tropic of Capricorn. The other half is filled with a net of parallels of the equator and of the meridian.[140] This plate is known as the *Ṣafīḥa Shakkāziyya* after the name of the inventor.

In 729/ 1328-29 ibn al-Sarrāj produced a specimen in Syria by substantially modifying the original design of al-Shakkāz. David King considers this specimen to be 'the most sophisticated astronomical instrument from the entire medieval and renaissance periods.'[141] This fourteenth century specimen is relevant for India in so far as it was imitated in the seventeenth century. The rete and the mater of this astrolabe (A125) which are extant do not carry any signature or date, but David King attributes these parts to Jamāl al-Dīn.[142]

3.2. Zarqālī Universal Astrolabe

Abū Isḥāq Ibrahīm ibn Yaḥyā al-Naqqāsh (d. 15 September 1100), known as al-Zarqālluh (in Latin writings, Azarquiel, Arzachel) was a contemporary of ᶜAlī ibn Khalaf.[143] He simplified the latter's universal plate by dispensing with the rete. Instead he added a diametral rule with a sliding cursor. On the plate, he drew celestial coordinates for both the ecliptic and equatorial axes and marked the positions of several stars.

Al-Zaqālluh designed another universal plate where he superimposed two *shakkāzīya* markings at an angle equal to the obliquity of the ecliptic. On the back are

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140 Turner 1985, p. 152-153.

141 King 2005, pp. 694-700.

142 King 2005, pp. 821-829.

143 On his biography, see Vernet.

the usual degree scales, zodiacal calendar, sine diagram, shadow squares and such elements as in the common astrolabes. This plate was equipped with an alidade at the back; in the front there is a diametral rule and a sliding cursor attached at right angles to the rule; both the rule and the cursor are graduated. Al-Zarqālluh named this universal plate *al-ᶜabbādiyya* in honour of the King of Sevilla, al-Muᶜtamid b. ᶜAbbād, but it became popular under the name *Safīḥa Zarqāliyya* (in Latin Saphaea Arzachelis).[144]

Anthony Turner lists nine extant specimens.[145] The most spectacular specimen of the *zarqālī* astrolabe was constructed by Ḍiyā' al-Dīn Muḥammad for a high Mughal dignitary Nawāb Iftikhār Khān in 1680 (A091).

Turner adds that 'the plate was difficult to use because of the profusion of markings.' For example, consider the complex procedure for measuring time as explained by Turner:[146]

> First the observer measured the altitude of the sun (or at night one of the stars marked on the astrolabe) by means of the alidade and the degree scale engraved on the back of instrument. Turning the astrolabe over, he set the rule to the latitude of the place of observation against the degree scale on the edge. When thus set, the position of the rule represented the place of observation. Having found, from the zodiacal calendar on the back, the sun's position in the ecliptic for the day of observation, the cursor was slid along the rule until the graduation on the cursor corresponding to the observed altitude of the sun met the parallel representing the sun's position in the ecliptic. The meridian of the equatorial pole that passed through this point (and which is equivalent to an hour arc) then indicated the time. If a star had been observed, the cursor was moved until the graduation corresponding to the star's observed altitude met one parallel of the star as marked on the instrument, the time being read off from the meridian passing through this point.

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144 Cf. Kaye 1918, pp. 27-30, plate VII; Hartner 1968b, pp. 316-317; Turner 1985, pp. 151 –179; Puig 1985; Puig 1989.

145 Turner 1985, pp. 177-178.

146 Turner 1985, p. 155.

3.3. Ibn Bāṣo's Universal Plate

In the thirteenth century Ibn Bāṣo of Toledo developed yet another universal plate by combining the elements from the universal astrolabes designed by ^{c}Alī ibn Khalaf and ibn al- Zarqalluh. [147] According to Emilia Calvo, this plate is difficult to use in practice, it serves more theoretical or pedagogical purposes. This plate was apparently very popular; Calvo enumerates some 27 specimens, most of them produced in the Maghreb. Allāhdād is the only astrolabe maker in India who incorporated this universal plate in his undated astrolabe (A002) and in an unsigned and undated astrolabe that can be attributed to him (A003). His descendants did not emulate him in this respect, although they were interested in other types of universal plates.

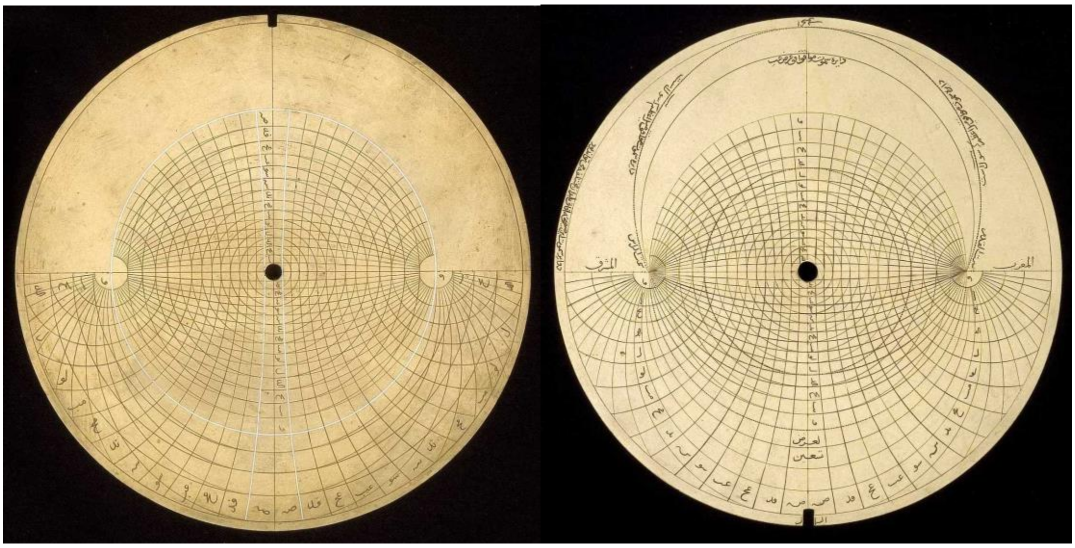

Figure A13 – Ibn's Bāṣo's universal projection; left: Allāhdād's undated astrolabe (A002); right: astrolabe attributable to Allāhdād (A003) (© Museum of the History of Science, Oxford)

3.4. North-South Astrolabes

While the standard astrolabes are northern astrolabes (*asṭurlāb shamālī*), there was a certain fascination in India for north-south astrolabes (*asṭurlāb shamālī wa janūbī*). Sulṭān Fīrūz Shāh Tughluq is reported to have commissioned three north-south astrolabes, one in brass, another in silver and the third in brass, but with large dimensions, which was designated as *Asṭurlāb-i Fīrūz Shāhī*.[148] The first Sanskrit manual on the astrolabe composed at his court by Mahendra Sūri also devotes the third

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[147] Calvo 2000, p. 266.

[148] Sarma 2000.

chapter to the construction of northern astrolabes (*saumya-yantra*), southern astrolabes (*yāmya-yantra*) and the composite north-south astrolabes (*saumya-yāmya-yantra*). The north-south astrolabe to which these sources refer is one in which the combined northern and southern projection is drawn on the rete and on the plates with five concentric circles representing the Tropic of Capricorn, Equator and the Tropic of Cancer, Equator and the Tropic of Cancer, in this order.[149] In the middle of the nineteenth century, Buhlomal constructed two north-south astrolabes which probably are of this type.[150]

The Lahore astrolabes exhibit three other variants. One of these astrolabes is made by Ḍiyā' al-Dīn Muḥammad in 1674 (A090) and the other two are attributable to him on stylistic grounds. In the first variant, the obverse side of the single plate is engraved as a latitude plate for 33° N and on it is superimposed a northern projection of the ecliptic circle together with the positions of 46 stars,[151] while the reverse side is designed for latitude 35° N on which a southern projection of the ecliptic circle is drawn and the positions of the same 46 stars, but with southern orientation, are marked. On both sides the positions of many stars are indicated by dots enclosed in small circles. There is a minimal rete consisting of just the zodiac ring. There is an alidade on which a slender sighting tube is mounted.

In the second variant (A103), the obverse side carries a double projection for latitudes 36° and 32°. On this is superimposed the ecliptic circle in its northern projection. The reverse side carries a quadruple projection for 22°, 25°, 27° and 29°. Upon these is superimposed the ecliptic circle in its southern projection. On both sides, many star positions are marked by dots inside small circles. Presumably it had the same type of rete and alidade but these are now missing.

The third variant (A104) is constructed much more elaborately. There are two nicely reticulated retes with northern and southern orientation respectively. There are

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149 See Ôhashi 1997, p. 215, Fig. 9.

150 Sarma 2015b, pp. 270-271, Fig. 7. These will be described in section B.

151 This plate shows close resemblance to the back of an astrolabe by ᶜUmar ibn Dawlatshāh ibn Muḥammad al-Kirmānī in 726 AH (AD 1325-26); see Linton 1980; no. 163, pp. 90-91; see also King 2005, p. 57, Fig. 5.1.3.

seven plates. Some sides carry northern projections and some others southern projections.

Yet another variant can be seen in an unsigned and undated Sanskrit astrolabe with a single plate (D025) which will be described in section D below. The obverse side carries the northern projections for latitude 27°; on the reverse side, an attempt to was made to trace the altitude circles with the southern orientation and these were not completed. There are two openwork retes with northern and southern orientations respectively.

3.5. *Zawraqī* Horizons and the associated Plates

An Andalusian feature incorporated in several astrolabes is the so-called 'ship' horizon or *zawraqī* horizon. It is represented on the rete as an arc straddling the equinoctial bar. It looks like the lower outlines of a boat (*zawraq*), the corresponding segment of the vertical meridian looking like the upright mast of the boat. Therefore, this arc is designed as *zawraqī* or ship horizon.

The *zawraqī* astrolabe was invented by al-Bīrūnī's contemporary Abu Saᶜīd Sijzī.[152] The main source of our knowledge of this variety of astrolabe is Josef Frank's *Zur Geschichte des Astrolabs*, [153] which deals with several non-standard astrolabes described by al-Bīrūnī in his *Kitāb fī istiᶜāb al-wujūh fī ṣan'at al-asṭurlāb.* Frank describes the astrolabe as follows:

> Of very special interest is the boat-shaped (*al-zauraqī*) astrolabe of Abū Saᶜīd al-Sijzī, which, in its construction, abandons the geocentric model that was generally accepted at his time, in so far as the horizon he designed is movable. The astrolabe consists of a fixed and a movable part. The former is the plate of the northern astrolabe without the azimuth lines. On the plate

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152 Wilfred de Graaf informs me (personal communication dated 4.6.14): 'A treatise by Sijzi on the Zawraqi astrolabe is found in a unique manuscript in Istanbul, Topkapi Palace Library, Ahmet III, 3342. There are no figures in this treatise. As you mentioned, the Zawraqi astrolabe is described in great detail by Biruni. The text by Biruni has recently been edited by Sayyid Muhammad Akbar Jawad Husayni and published in Mashhad in 1422 H (lunar). In this publication, however, partly incorrect figures appear. Slightly better figures can be found in an original manuscript, which is now in Leiden (ms. Leiden, Or. 591).'

153 Frank 1920, pp. 18-21.

> are drawn, furthermore, the projections of the zodiac and of the fixed stars, as they are shown in the rete of the northern astrolabe. … The movable part is an arc cut out from a metal plate which can be rotated … at the point through which the axis of the astrolabe passes. The convex edge of the arc is the projection of the horizon of the locality for which the plate is calibrated; … Firmly attached to the arc is a ruler with a pointed end—attached in such a way that when the arc coincides with the horizon line drawn on the plate, the ruler rests on the meridian line. … The main advantage of this astrolabe against the common astrolabe is the simple shape of the movable part; the use is, however, much more complicated.'[154]

Frank dwells on the various uses of this astrolabe and concludes with the remark:

> 'From the foregoing, one can see that for solving even simple problems two or more operations are necessary, whereas just one operation would often suffice with the common astrolabe.'

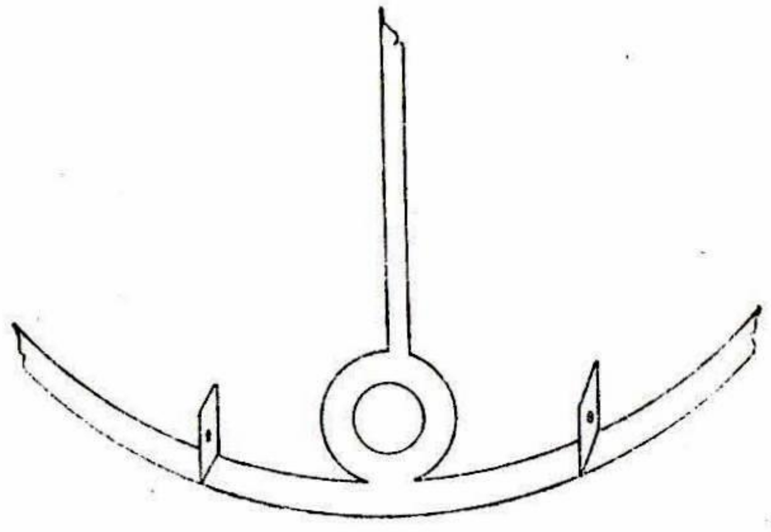

Figure A14 – The rete of a *zawraqī* astrolabe (from Frank 1920)

Astrolabes with this design may have been made and used at the time of its invention in the eleventh century and later, but no such astrolabes are extant today. All that exists now are the ten Lahore astrolabes in which one or two *zawraqī* horizons are

154 My translation from Frank's German with slight modifications.

incorporated in the otherwise standard retes and which contain a special plate to be used along with the *zawraqī* horizons.

The first step in this direction seems to have been taken by Qā'im Muḥammad who incorporated two arcs in the rete of an astrolabe he made in 1635 (A013).[155] Here both the arcs are curved towards the north; on the upper arc are engraved the names of six zodiac signs from Aries to Virgo; the function of this arc is not known. The lower arc carries the legends 'The Horizon of the Western Solid' and 'The Horizon of the Eastern Solid.'[156] Obviously this arc is the proper *zawraqī* horizon. This has to be used with a special type of projection engraved on one of the plates, which Gunther describes thus: 'a complicated plate in the centre of which is a miniature tablet for lat. 42°, hours 15. Across the bottom is written "A table of the projection of rays", which according to Albiruni is also called "equalization of houses".'[157]

Two short mutually intersecting horizons for latitudes 30° and 33° are added to the rete in an unsigned astrolabe that can be attributed Qā'im Muḥammad (A016). Some plates are missing in this astrolabe; it is not known whether there was a plate to be used with the *zawraqī* horizons. Seven astrolabes by Ḍiyā' al-Dīn (two are signed by him: A073 and A082; others are attributable to him: A093, A099, A100, A101 and A103) carry these *zawraqī* horizons. Finally, a horizon for 40° occurs in an astrolabe by Jamāl al-Dīn (A121).

There is some variation in the horizons and in the plates that accompany them. In some astrolabes, the horizons are rather short, drawn inside the ecliptic ring. In others they are long, passing through the two equinoxes and reaching up to the Capricorn ring on both sides. The latitudes for which the horizons are drawn also vary.

In four astrolabes by Ḍiyā' al-Dīn, the horizons are for latitudes 29° (Delhi) and 32° (Lahore). In one astrolabe, he has just one horizon for latitude for 32° (Lahore) and in another for latitude 24° (Tropic of Cancer?). Finally, in one astrolabe (A102), there is a special rete consisting of just two horizons for latitudes 37° and 38°. On the other

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155 Oxford, Museum of the History of Science, accession no. 42730. See also Gunther 1932, no. 71, pp. 191-197, Plates XLV-XLVI, figs. 94-97.

156 Rendered thus by Gunther 1932, p. 192.

157 Gunther 1932, p. 194.

hand, in one of his astrolabes, Qā'im Muḥammad has just one horizon probably for 42° (A013) and in the other for latitudes 30° and 32°. Finally, Jamāl al-Dīn has a horizon for 42°.

The plates which are designed for use are highly complex. These are broadly of two types, those to be used with the short horizons and those to be used with the longer horizons. On the plates to be used with short horizons, first the oblique horizons at the desired latitudes are drawn and then the astrological houses or rather the markings for determining the astrological 'projections of the rays', divided for every 6° at these desired latitudes. Then inside the circle of Cancer a miniature plate is engraved with oblique horizons and markings for determining the 'astrological rays'. In addition, there are engraved a graduated ecliptic ring and the positions of some stars indicated by dots enclosed in small circles. The whole plate is designated as *ṣafīhat maṭraḥ al-shu*^{c}*ā*^{c} *kahtrd* (?) *abī rayhān taswīyat al-buyūt khwānand,* 'plate for finding the projection of the astrological rays according to (?) Abū Rayhān [al-Bīrūnī] [and] equalization of the astrological houses' (see A013, A082 and A093).

Figure A15 – Short horizons at latitudes 29° and 32° on the rete of the astrolabe made by Ḍiyā' al-Dīn in 1663 (= Figure A082.3)

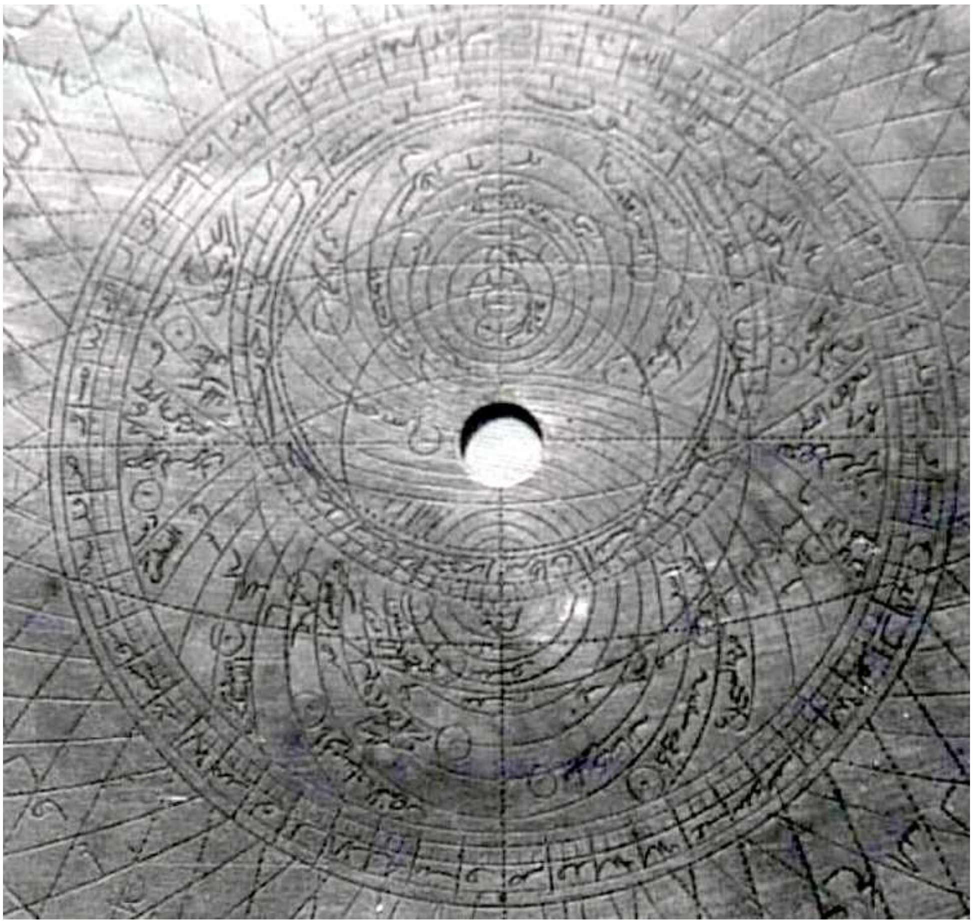

Figure A15. Miniature plate for use along with the short horizons in the astrolabe made by Ḍiyā’ al-Dīn in 1663 (= detail of Figure A082.4)

The plates to be used with the long horizons are engraved with the oblique horizons and astrological houses at the desired latitudes. The positions of the stars which are on the rete are marked here by dots inside small circles. For example, two long horizons at latitudes 29° and 32° are incorporated in the rete of the astrolabe A099 which is attributable to Ḍiyā al-Dīn. Two separate plates are designed for using with these horizons. First there is a plate on which astrological houses are marked for the latitudes 29° and 32°. The second plate carries projections of the altitude circles, azimuth arcs and hours lines for latitude 29° as in a normal plate. Superimposed upon these is the ecliptic circle, divided into signs and groups of 6°, and also the positions of the same 46 stars which are on the rete.[158]

158 Like the obverse side of the North-South astrolabe by Ḍiyā’ al-Dīn (A090), described previously, this plate also shows close resemblance to the back of an astrolabe by ᶜUmar ibn Dawlatshāh ibn Muḥammad al-Kirmānī in 726 AH (AD 1325-26); see Linton 1980; no. 163, pp. 90-91; see also King 2005, p. 57, Fig. 5.1.3.

Figure A16. Long horizons at latitudes 29° and 32° in the rete of an astrolabe attributable to Ḍiyā al-Dīn (= Figure A099.2)

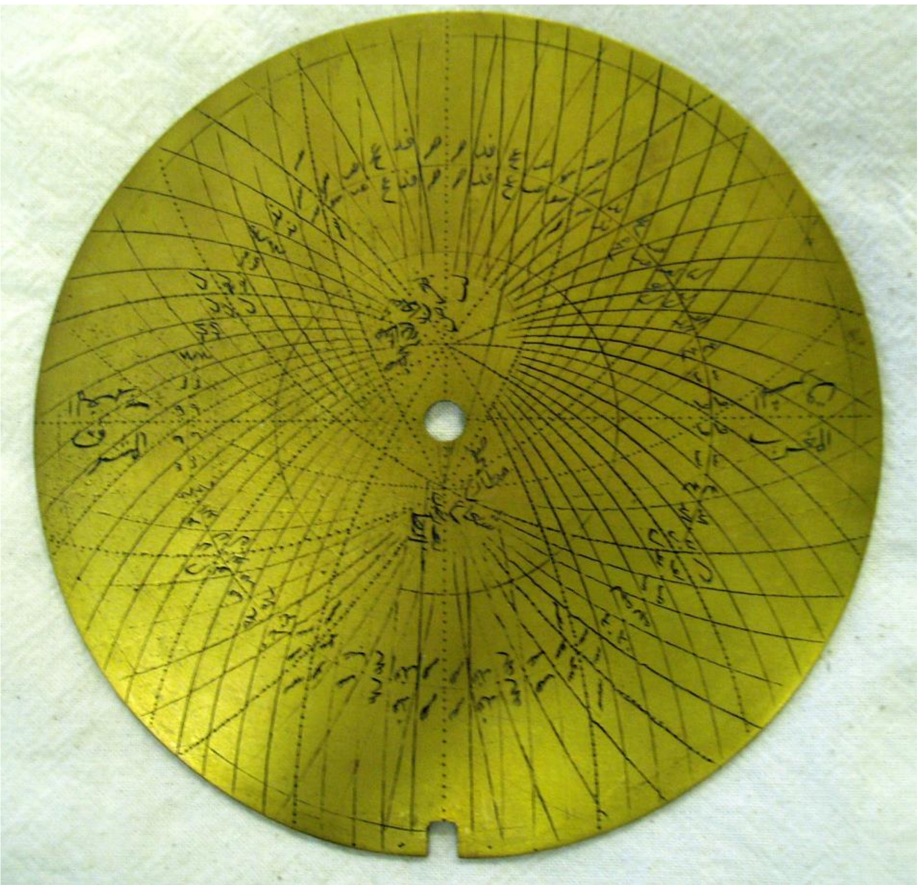

Figure A16 – Astrological houses at latitudes of 29° and 32° in an astrolabe attributable to Ḍiyā al-Dīn (= Figure A099.3)

Figure A17 – Plate for latitude 29° with the ecliptic and the positions of 46 stars marked with their names an astrolabe attributable to Ḍiyā al-Dīn (= Figure A099.4)

The following table gives a consolidated overview of the *zawraqī* horizons and the plates with special markings in the ten Lahore astrolabes.

Table A4 ***Zawraqī* Horizons and Plates**

	Astrolabe number	***Maker and Date***	***Horizons***	***Special plate***
1	A013	Qā'im 1635	1 short arc for 42°	Plate with a miniature plate inside in the circle of Cancer
2	A016	Qā'im attributable	2 short Arcs for 30° + 33°	Not available

	Astrolabe number	*Maker and Date*	*Horizons*	*Special plate*
3	A073	Ḍiyā’ al-Dīn 1657	1 short arc for 32°	Plate with a miniature plate
4	A082	Ḍiyā’ al-Dīn 1663	2 short arcs for 29°+32°	Plate with a miniature plate
5	A093	Ḍiyā’ al-Dīn attributable	2 short arcs for 29°+32°	Plate with a miniature plate
6	A099	Ḍiyā’ al-Dīn attributable	2 long arcs for 29°+32°	Plate for 29° with several star positions; another plate with markings for astrological ‘projections of the rays’ at 32° and 36°
7	A100	Ḍiyā’ al-Dīn attributable	2 long arcs for 27°+36°	Plate for 27° with a graduated ecliptic ring and some 24 star positions; another plate for 36° with a graduated ecliptic and about 23 positions of stars, some of which are not identical with those marked on the plate for 27°
8	A101	Ḍiyā’ al-Dīn attributable	Long arc for 24°	Plate for 24° with several star positions marked, but no markings for astrological ‘projections of the rays’
9	A102	Ḍiyā’ al-Dīn attributable	Separate rete for oblique horizons of 37° and 38°	There is no plate designed for use with these *zawraqī* horizons
10	A121	Jamal 1666	Long arc 40°	Plate for 40° with star positions; another plate with markings for astrological ‘projections of the rays’ at latitudes 32° and 36°

What advantages these ‘ship’ horizons and the associated plates bestow is not clear. We may recall Joseph Frank’s remark that ‘for solving even simple problems [with the *zawraqī* astrolabe] two or more operations are necessary, whereas just one operation would often suffice with the common astrolabe.’ Is this merely a case of piling up complexities for displaying virtuosity?[159]

3.6. *Qibla* Maps

By the thirteenth century, the Islamic astrolabes are generally equipped with geographical tables with the longitudes, latitudes, *inḥirāf* (azimuth of *qibla,* i.e., the direction of Mecca), *jahat* (compass direction of Mecca in relation to the observer’s locality) and *masāfat* (the linear distance to Mecca). The next step in this development are the maps on which the *qibla* direction is graphically displayed.

In his astrolabe of 1666 (A121), Jamāl al-Dīn engraved a *qibla* map on the inner surface of the mater. There the left hand side carries a geographical gazetteer arranged according to climates. On the right half is the *qibla* map where some 17 localities are marked by means of small circles in the appropriate positions with respect to Mecca.

Twenty years later, in 1686, Jamāl al-Dīn’s brother Ḥāmid produced a massive instrument which contains a standard astrolabe and a *qibla* indicator (A112). On several plates, Mecca is placed at the centre and radial lines all around are connected to different localities mainly in India and Greater Iran.

3.7. Circle of the Visibility of Canopus (*Suhayl*)

The last non-standard feature in the Lahore astrolabes is a circle indicating the visibility of the star *Suhayl* (α Carinae, Canopus) which Qā’im Muḥammad engraved on most of the plate faces of his astrolabe of 1635 (A013). On plates for 32°, 35° and 38°, it is seen as a full circle, but on the plates for lower latitudes the circle is not complete. On the western side of this circle is the label *l’m^{c}arifat al-ṭalū^{c} al-suhayl,* ‘for the knowledge of the rising of Canopus’ and the eastern side *l’m^{c}arifat al-gharūb al-suhayl,* ‘for the knowledge of the setting of Canopus’.

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159 King 2005, p. 806, emphasises the necessity of studying ‘*zawraqī* markings which have still not been properly explained in the modern literature, in order to document their origin in earlier (that is 9th- and 10th-century) textual sources.’ It is still a desideratum.

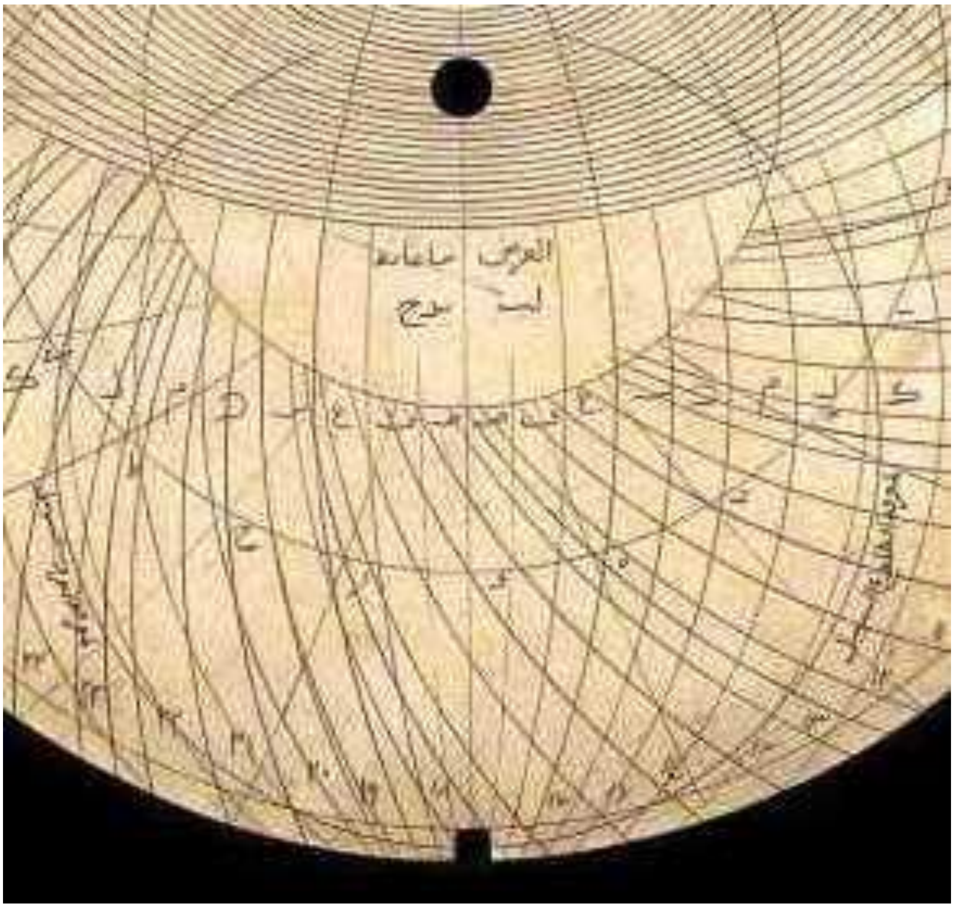

Figure A18 – Canopus circle on the plate for latitude 32° (detail of Figure A013.3) (© Museum of the History of Science, Oxford)

Canopus is the second brightest star in the heavens. Because of its extreme southern location, it is not represented on astrolabe retes, but on celestial globes it is shown in the lower rudder of the ship Argo Navis.[160] It has a declination of about 52;30° south and therefore it is not visible above the horizon at latitudes lower than 37;30° N.[161]

In Sanskrit, the star is called *Agastya* and Hindus celebrate the first visibility of Canopus after the rainy season with a certain ritual called *Agastya-pūjā* (worship of Canopus). On this, Michio Yano writes as follows:

> The heliacal rising (the first appearance before dawn) of the star *Agastya* (Canopus) is an important astronomical phenomenon concerned with

160 Savage-Smith 1985, pp. 200-201, Fig. 81; see also Kunitzsch 1959, pp. 208-210.

161 In a personal communication of 28 May 2015, Professor Michio Yano informs me as follows: 'Since Canopus (Agastya)'s declination is about 52.5 degrees south, it can be seen at the place whose geographical latitude is lower than 37.5 degrees north. The lower the latitude the longer is the period of its visibility. At the latitude of Delhi, the star can be seen after mid-August and for quite a long time.'

> weather prognostics. With this phenomenon the rainy season comes to an end and the sky clears. *Pūjā* was performed in the dawn of the first appearance of *Agastya,* and the fortunes of the kings, individuals, and states were foretold. … The date of *Agastya's* first appearance depends on the geographical latitude.[162]

It is highly doubtful that Qā'im Muḥammad was aware of this Hindu custom. No other Lahore astrolabe carries this circle; in fact, no other astrolabe anywhere seems to have this circle as it is not mentioned in any published literature on the astrolabes. It is, therefore, difficult to determine Qā'im Muḥammad's source. That the star does not rise very high above the horizon is indicated by the placement of the circle mostly below the horizon. But it is strange that Qā'im draws the circle of visibility also on the plate for latitude 38° where the possibility of Canopus rising above the horizon is minimal.

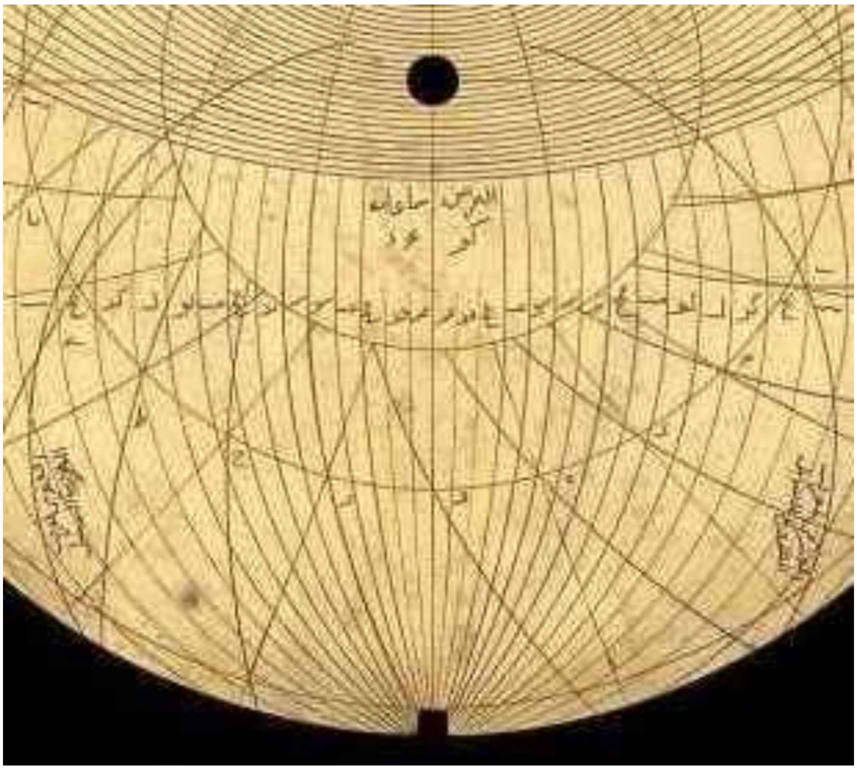

Figure A19 – Canopus circle on the plate for latitude 27° in astrolabe A013
(© Museum of the History of Science, Oxford)

162 Yano 1994, pp. 233. In the following pages, he cites the statements of several Sanskrit texts on the time of the first visibility of Canopus in terms of the sun's position in the zodiac and then a table showing the heliacal risings for each degree from 20° to 37°. See also Rao et al 2016.

I append here the remarks on the plate for latitude 32° verbatim, which James Morrison kindly sent me on 26 and 27 May 2015.

> I took a quick look at the visibility of Canopus at a latitude of 32 deg N. It culminates at only about 5.3 deg above the horizon. This altitude can never be reached on a normal astrolabe plate, which is limited to declinations greater than -23.5 deg. Based on a very quick look, it appears that Canopus would be visible for at least part of a day from about April to early November. That is, Canopus is above the horizon when the Sun is below the horizon. …
>
> I've been looking at the visibility of Canopus at latitude 32 deg. I have been using my program, 'The Electric Astrolabe' to visualize it. It looks to me like it goes something like this: (all dates and positions are for 1635). On about 21 Feb (Pisces 4) Canopus rises just as the Sun sets. Canopus is then visible above the horizon until it sets 4:48 hrs later.
>
> It will continue to be visible at night until it rises just before the Sun on about 28 August (Virgo 4). So, Canopus is visible at night for about 6 mos. of the year. The rising time changes daily by the length of a sidereal day. Canopus' rising time will be about 4 min. earlier each day. This time difference is reflected by the Sun's daily change in longitude on the ecliptic.
>
> When Canopus is visible it is above the horizon for the same amount of time each day; 4:43 (approx.) The question the maker may have been trying to resolve is which 4:43 it can be seen. That is, the rising time of Canopus. His problem was how to represent Canopus when Canopus cannot be shown on the astrolabe. The circles must be his solution.
>
> I notice the Canopus arcs intersect the horizon at the azimuth angle equal to the plate latitude. Could this be a clue? Also, the star Alkaid rises very close to the rising of Canopus and could be used. That is, if Alkaid is visible, so is Canopus. I have not found another star with the same setting time. What mystifies me is why the arcs are circular.

ALLĀHDĀD

The patriarch of the Lahore family of astrolabe makers is Allāhdād (*fl.* 1567).[163] Two astrolabes signed by him are extant. The first is dated AH 975 (AD 1567-68) and is now with the Salar Jung Museum at Hyderabad (A001). The second one, which is not dated, is preserved in the Museum of History of Science at Oxford (A002). On both these astrolabes, he signed his name as Ustād Allāhdād Asṭurlābī Lāhūrī, thus proclaiming himself to be a master craftsman (*ustād*) and a resident of Lahore (*lāhūrī*). Allāhdād's son ᶜĪsā refers to himself, on his own astrolabes, as the son of 'Allāhdād Asṭurlābī Lāhūrī Humāyūnī.' Thereafter, this practice is followed by all members of the family; on the astrolabes and celestial globes crafted by them,[164] they mention their full ancestry beginning with Allāhdād Asṭurlābī Lāhūrī Humāyūnī.

There has been some controversy about the meaning of the epithet *humāyūnī* which, in conjunction with *asṭurlābī,* can only mean the 'astrolabe maker to Humāyūn.' Gunther renders the epithet *humāyūnī asṭurlābī* as the 'royal astrolabe maker'[165] and Nabia Abbott supports this view.[166] Sulaiman Nadvi refutes this saying that the term *humāyūnī* does not have the connotation 'royal'.[167] On the other hand, he speculates that Humāyūn must have invented a special kind of astrolabe which was called *humāyūnī asṭurlāb* and that the members of the Lahore family who manufactured such astrolabes received therefore the sobriquet *asṭurlābī humāyūnī.*[168] But there is no basis for this hypothesis; the astrolabes made by the members of the Lahore family are largely of the conventional type and some of the innovations they made there, as will be shown in this Catalogue, were originally invented in Andalusia in the tenth and eleventh centuries and not by Humāyūn in the second half of the sixteenth century.

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[163] His name is variously transliterated in modern literature: Ilāhādād, Allāh Dād, al-Haddād and so on; cf. Abbott 1937, p. 146; Savage-Smith 1985, p. 301, n. 138 and Dar 1994, 174.

[164] Except when the instruments are too small for the long signature.

[165] Gunther 1932, pp. 187, 197, 208.

[166] Abbott 1937, p. 146.

[167] Nadvi 1937a.

[168] Nadvi 1935, p. 626.

Savage-Smith argues ‘that the name Humāyūnī was used to indicate contemporaneity of Allāhdād with Humāyūn and that even if the founder of the workshop [at Lahore] had enjoyed royal favour, his descendants probably did not.’[169] In fact, the descendants also did enjoy royal patronage as will be shown in the following pages. Savage-Smith herself describes a special kind of celestial globe made by Ḍiyā’ al-Dīn Muḥammad for Aurangzeb in 1679 and states that on this globe Ḍiyā’ al-Dīn refers to himself as the descendant of Allāhdād Humāyūnī.[170] Surely, on this globe made for the Emperor Aurangzeb, Ḍiyā’ al-Din would not be using the attribute *humāyūnī* with the name of his ancestor merely to express Allāhdād’s contemporaneity with Humāyūn, but to stress the fact that Allāhdād made astrolabes for Humāyūn and that his family enjoyed the patronage of Mughal royalty from Humāyūn onwards.

It is, however, true that Allāhdād’s only dated astrolabe was made in 1567, i.e. eleven years after Humāyūn’s death. But this does not preclude Allāhdād’s manufacturing other astrolabes in Humāyūn’s lifetime for the use of the emperor who is said to have been interested in astrolabes and celestial globes. Humāyūn’s sister Gulbadan Begam reports that when he became impatient of waiting for Hamīdā-bānū Begam’s consent to marry him, ‘his Majesty took the astrolabe into his own blessed hands, and having chosen a propitious hour, summoned Mīr Abū‘l-baqā and ordered him to make fast the marriage bond.’[171] It would be nice to imagine that the astrolabe which Humāyūn took into his blessed hand was crafted by Allāhdād. It is also perfectly legitimate that Allāhdād’s descendants should commemorate the royal patronage extended to their ancestor by calling themselves the descendants of the Asṭurlābī Humāyūnī.

Allāhdād’s grandson Muḥammad Muqīm adds sometimes ‘Shaykh’ to Allāhdād’s name (A021 etc) and once ‘Mullā Shaykh’ (A032).[172] Allāhdād’s great-grandson Ḍiyā’ al-Dīn Muḥammad adds often ‘Mullā’ to Allāhdād’s name (A059 etc) and once to the

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[169] Savage-Smith 1985, p. 37.

[170] Savage-Smith 1985, pp. 42-43, 232, Figure 17.

[171] Gulbadan Begam, p. 151.

[172] According to Steingass 1892, the epithet *Shaykh* has the following meanings: venerable old man, man of authority, chief, learned in religion and law, etc.; the term *Mullā* connotes a learned man, judge, priest and so on.

names of all the ancestors, i.e. father Qā'im Muḥammad, grandfather ᶜĪsā and great-grandfather Allāhdād (A061) and once even to his own name (A064).

The two astrolabes which carry Allāhdād's signature are unusually large and heavy. The dated piece at Hyderabad measures 199 mm in diameter. The other one at Oxford is still larger with a diameter of 256 mm. On the various plates in both these astrolabes, some of the circles are inlaid with silver, a feature not met with in any other astrolabe. Obviously these astrolabes were not made for the daily use of common astronomers but were meant for the high nobility as ostentatious show-pieces. The two astrolabes differ from one another not only in size but in respect of ornamentation as well. In the Hyderabad astrolabe, the crown-like projection at the top (*kursī*) is solid and the various star-pointers in the rete (*ᶜankabūt*) are joined by archaic patterns. In the astrolabe at Oxford, on the other hand, the *kursī* is pierced with a finely cut design and the star-pointers are joined by a delicate floral tracery. These two features became the hallmark of the Lahore astrolabes.

The Hyderabad astrolabe has five plates to serve the latitudes 21;40° (Mecca), 28;20° (Delhi?), 30°, 33;15° (Baghdad), 34°, 37°, 38°, 39;37° (Samarqand), 45°, and a tablet of horizons of the eastern type. The astrolabe at Oxford has six plates calibrated for latitudes 21;40° (Mecca), 27° (Agra?), 30°; 33;25° (Baghdad), 34;30°, 37°, 38°; 39;47° (Samarqand), 45°, a tablet of ecliptic coordinates, a tablet of horizons of the western type, and a universal plate for all latitude originally designed by Ibn Bāṣo. Thus, the plates are not latitude-specific, but locality-specific. Although Allāhdād calls himself *lāhūrī,* it is surprising that in either astrolabe there is no plate for Lahore which lies on 31;50°. Interestingly, the Oxford astrolabe shows two uncommon features: the tablet of horizons of a type which is common in the astrolabes made in the Maghreb and the universal plate for all latitudes which was originally invented by Ibn Bāṣo in Andalusia in the eleventh century.

On the inner side of the mater, Allāhdād engraves a geographical gazetteer with five separate columns for the names of cities, their latitudes, longitudes, *inḥirāf* and the duration of the longest day. The majority of these cities are from the Middle East, starting from Mecca at 21;40° and reaching up to Samarqand at 39;37°. But there are also a few Indian cities, and this number increases with each successive descendant. The Hyderabad astrolabe has a gazetteer of 96 cities, but the cells meant for the *inḥirāf* and

the longest day are not filled in at all. The Oxford astrolabe contains a gazetteer of 157 localities. Here the cells meant for *inḥirāf* and the longest day are filled partially, some by the astrolabe maker himself and some by a later hand in a much smaller script; but there are many cells in these two columns which are blank.

On the back, in both astrolabes, the upper half of the rim carries the altitude scales and the lower half cotangent scales. There is a sexagesimal trigonometric quadrant in the upper left with 60 horizontal lines and a solar quadrant in the upper right with equidistant arcs of the signs of the zodiac. In the lower half are engraved two shadow squares and inside these an elaborate table which combines several astrological tables.

Besides these two astrolabes, there are two other astrolabes which share some of the features of these two astrolabes and are therefore attributable to Allāhdād. One of these is in the Museum of the History of Science at Oxford (A003) and the other in the National Maritime Museum at Greenwich (A004). There is a great similarity in the workmanship of 0 and A003; their retes are almost alike in their design and have exactly the same 36 star pointers. Both contain Ibn Bāṣo's universal plate for all latitudes.

Likewise, there is much in common between A001 and A004. Both have solid *kursīs* of identical design and the retes in both are similar. As in A001, the geographical gazetteer in A004 has provisions for longitudes, latitudes, *inḥirāf* and the duration of the longest day, but the last two columns are not filled in. There are five plates in A004; some of the sides were engraved by Allāhdād and some by another person. The limb on the front of the mater was engraved by Allāhdād, but the back by another person who drew a graph for the midday solar altitude at latitude 32°. Therefore, this second person must be contemporary and worked on the astrolabe together with Allāhdād; it is quite likely that this second person was Allāhdād's son ᶜĪsā whose astrolabes contain graphs for the midday solar altitude at latitude 32°.

A001 and A004 are stylistically alike and must have been produced about the same time ca. 1567. The other two A002 and A003 show greater refinement in design and must have been produced some time later.

Since his descendants invariably trace their genealogy back to Allāhdād, it may be assumed that he migrated to Lahore and set up his workshop there at the behest of Humāyūn. He may have come from Samarqand. The diversity of styles in astrolabes, the absence of a latitude plate designed for the latitude of Lahore and the incomplete

gazetteers indicate that he was experimenting with various features. However, in the two astrolabes at Oxford (A002 and A003) can be seen the beginning of the stylistic peculiarities which characterize the Lahore school.

A001⊙ ASTROLABE BY ALLĀHDĀD, AH 975 (AD 1567-68)

Diameter 199 mm

Hyderabad, Salar Jung Museum (#113/1/xxxv)

CCA 1120; Répertoire 1

Figure A001.1 – Front of the astrolabe (photo by S. R. Sarma)

This is the earliest extant astrolabe manufactured in India. In fact, it is the earliest dated scientific instrument of India that is extant today. It is a rather large and heavy piece with silver inlay. It could not have been meant for the daily use of a common astronomer, but only as an ostentatious showpiece kept by a high nobleman.

Components

Body with *kursī* (d. 199, h. 244, t. 11.5) with shackle and ring, rete for 28 stars, and 5 plates. The alidade with a sighting tube, bolt and wing nut are recent replacements.

Front

The astrolabe is suspended by a circular ring with a diamond-shaped cross-section. To this is attached a shackle. Its upper part has a trefoil shape with a hexagonal cross-section. The lower part of the shackle is riveted to the top of the *kursī.*

The *kursī* is high and solid, with seven lobes in each profile. The lower-most lobe is longer and more prominent; it is pierced by a hole, a feature that occurs in several middle-eastern Kufic astrolabes. The *kursī* is surmounted by trifoliate finial. On the front of the *kursī* a geometrical pattern is engraved on the surface. With a few exceptions, all other astrolabes produced in the family have openwork *kursīs*, and none have such a surface decoration with a geometrical pattern. Indeed, Allāhdād's second astrolabe at Oxford has an exquisitely pierced *kursī.*

The body, the rim and the *kursī* are cast as one piece. The rim of the mater measures 12 mm in width and carries two scales. The outer one is graduated in groups of 5° and labelled clockwise from 5° to 360° in *abjad* notation. The inner scale is graduated in single degrees of the circle.

Rete

The rete consists of the three rings of the Tropic of Capricorn, the celestial equator and the ecliptic which are held together by the equinoctial bar which is counter-changed at the middle. The solstitial bar is shown only in the upper half.

Figure A001.2 – Rete of the astrolabe (photo by S. R. Sarma)

Large arcs of the circle representing the equator are shown both within and below the ecliptic. The ecliptic ring is divided into 12 signs of the zodiac and labelled with their names. Each sign is further subdivided in groups of 6° and 2° but not labelled. The most distinctive feature of the rete is the segment of the equator with several star pointers enclosed inside the ecliptic ring; two large pointers arising from the ecliptic ring above cross this segment of the equator.

There are 28 star pointers on the rete. These exhibit an archaic pattern of tiger's claws, sometimes with two or three lobes. This style is not emulated by any other member of the family. Even in his second astrolabe (A002), Allāhdād adopts a floral tracery to connect the star pointers, and this becomes the hallmark of the retes manufactured not only in this family but of all Mughal astrolabes in general. Moreover, the present rete contains a higher content of copper than the other components of this

astrolabe. Therefore, one is inclined to consider this rete to be a replacement for a lost original which may have contained a floral tracery. However, retes with such design occur in three other astrolabes.[173] All these three could not have been replacements. This rete design, therefore, appears to represent a minor tradition of Lahore.

Table A001-1 Stars on the Rete

	Star Name	Identification
1	*Rās al-Ḥūt*	γ Piscis
2	*Rijl al-Musalsala*	γ Andromedae
3	*Rās al-Ghūl*	β Persei
4	*Mirfaq al-Thurayyā*	α Persei
5	*ᶜAyn al-Thawr*	α Tauri
6	*Al-ᶜAyyūq*	α Aurigae
7	*Rijl al-Jawzā' al-Kubrā*	β Orionis
8	*Yad al-Jawzā' al-Yusrā*	γ Orionis
9	*Al-Shiᶜrā Yamānī*	α Canis Majoris
10	*Al-Shiᶜrā al-Shāmī*	α Canis Minoris
11	*Fard al-Shujāᶜ*	α Hydrae
12	*Qalb al-Asad*	α Leonis
13	*Ẓahr al-Asad*	δ Leonis
14	*Janāḥ al-Ghurāb*	γ Corvi
15	*Al-Simāk al-Aᶜzal*	α Virginis

173 Similar retes are to be seen in two other astrolabes of this family: an unsigned and undated astrolabe at the National Maritime Museum, Greenwich, which is attributed to Allāhdād (A004) and an undated astrolabe by Muḥammad Muqīm at the Lahore Museum (A034). A similar rete occurs also in an astrolabe (B001) at the Oriental Museum, Moscow, which is said to be a copy made by an unknown person in 996/1587 at Lahore of the original astrolabe made in Khorasan for Mīrzā Bāysunghur, who is probably identical with Mīrzā ibn Bāysunghur (1422–1457), the son of the Timurid prince Ghiyāth al-Dīn Bāysunghur; cf. Maslikov & Sarma 2016.

	Star Name	Identification
16	*Al-Simāk al-Rāmiḥ*	α Bootis
17	*Nayyir al-Fakka*	α Coronae Borealis
18	*ᶜUnuq al-Ḥayya*	α Serpentis
19	*Rās al-Hawwā'*	α Ophiuchi
20	*Al-Wāqīᶜ*	α Lyrae
21	*Minqār al-Dajāja*	β Cygni
22	*Al-Nasr al-Ṭā'ir*	α Aquilae
23	*Dhanab al-Dālfīn*!	ε Delphini
24	*Al-Ridf*	α Cygni
25	*Mankib al-Faras*	β Pegasi
26	*Matn al-Faras*	α Pegasi
27	*Dhanab al-Qayṭus*	ι Ceti
28	*Al-Khāḍīb*	β Cassiopeiae

PLATES

There are 5 plates containing stereographic projections for nine different latitudes and the tablet of horizons. On all the plates, vertical and horizontal diameters are drawn, and also the three concentric circles of the tropics and equator. On the latitude plates, altitude circles are drawn for each 2°. The numbers of these circles move inwards from the outer to the middle circle and then up to meridian, forming a rounded M shape. Azimuth arcs are drawn only below the horizon for each 10° and numbered along the lower half of the equatorial circle. Lines are drawn for seasonal hours and for equal hours counted from the western and eastern horizons.

The prime vertical, the oblique horizon, and the curves for equal hours counted from the western and eastern horizons are inlaid with silver. This is an unusual feature, not to be met with anywhere in the extant astrolabes.

Below the horizon the words *al-maghrib* and *al-mashriq* are engraved in the west and east respectively. The latitude and the duration of the longest day at this latitude are engraved in the space between the horizon and the circle of Cancer to the right and left of the meridian line respectively.

The plates serve the following latitudes:

Table A001-2 Plates

	φ	Longest day	(locality)
1a	21;40°	13;20 hours	(Mecca)
1b	33;25°	14;12 hours	(Baghdad)
2a	30;0°	13;57 hours	
2b	37;0°	14;34 hours	
3a	38;0°	14;40 hours	
3b	45°	15 hours	
4a	28;20°	12;49 hours[174]	(Delhi?)
4b	Tablet of horizons		
5a	34;0°	14;17	
5b	39;37°	14;52	(Samarqand)

The latitude plates are locality specific rather than latitude specific. Although Allāhdād calls himself a Lāhūrī, 'resident of Lahore,' there is no plate for the latitude of Lahore. It is also strange that the latitude of what is probably Delhi is widely off the mark. Plate no. 4a mentions it as 28;20° but in the geographical gazetteer it is mentioned as 28;15°. But the more accurate value 28;39° was known as early as 1370.[175]

The plates for 21;40° and 33;25° are clearly intended for Mecca and Baghdad. Remarkable is also the fact that the five plates exhibit slightly different colouration,

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174 12;49 hours is clearly a mistake. It should read 13;49.

175 Cf. Mahendra Sūri, p. 18 et passim.

suggesting that they were cut from different sheets of brass with varying proportion of copper. But the style is the same; they were made by the same man. The rete also appears to contain more copper than the rest of the components.

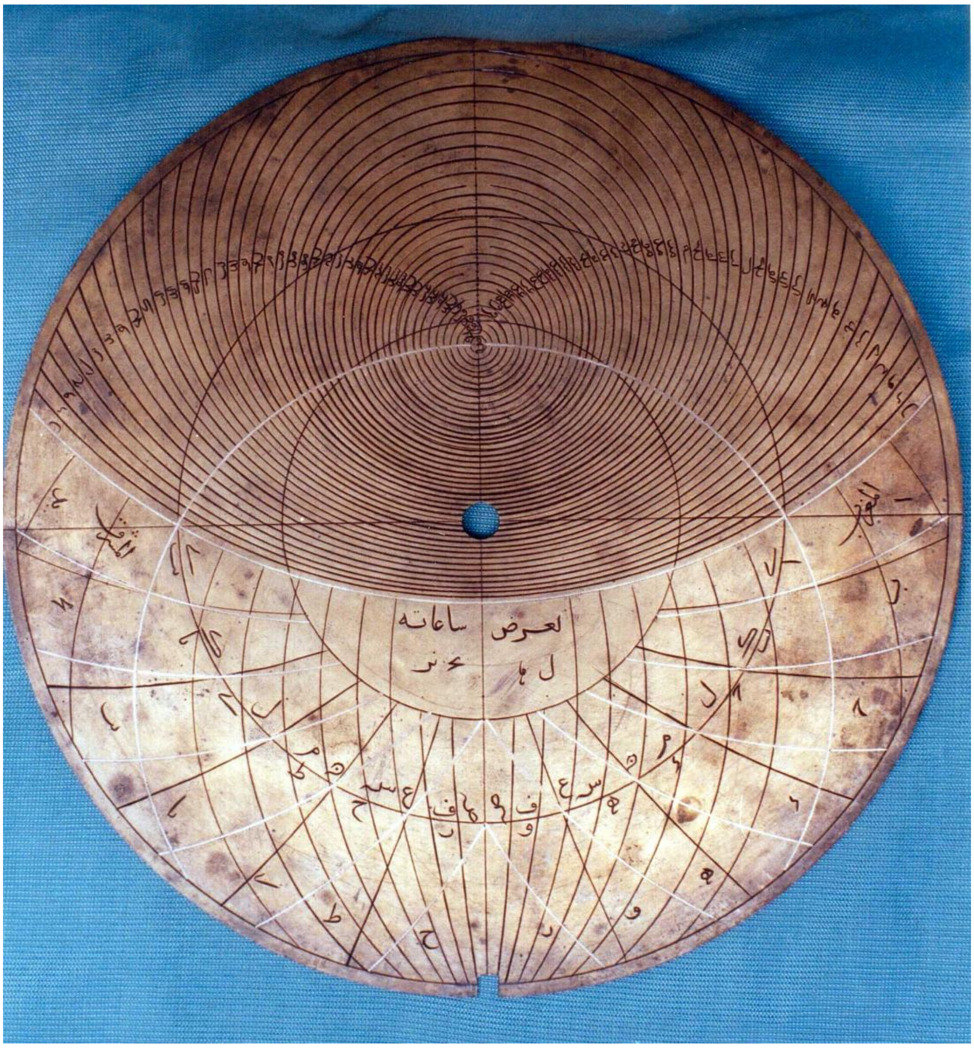

Figure A001.3 – Plate for the latitude of 30° (photo by S. R. Sarma)

Plate 4b bears four sets of half-horizons for latitudes from 10° to 72°. There are no declination scales. The latitudes served are:

10	18	26	34	42	50	58	66
12	20	28	36	44	52	60	68
14	22	30	38	46	54	62	70
16	24	32	40	48	56	64	72

Figure A001.4 – Geographical Gazetteer (photo by S. R. Sarma)

GEOGRAPHICAL GAZETTEER

On the inner side of the mater, there is a geographical gazetteer of 95 cities, engraved in two circles of five concentric rows. For each entry, five cells are allotted to carry respectively the names of the localities (*al-bilād*), their longitudes (*al-ṭūl*), latitudes (*al-ʻarḍ*), their orientation towards Mecca (*al-inḥirāf*) and the duration of the longest day (*al-sāʿāt*) at that latitude. The majority of the localities is from the Middle East, starting from Mecca at 21;40° N and reaching up to Samarqand at 39;37° N

latitude. But there are also a few (about 10) Indian cities, and this number grows with each successive descendant. Surprisingly enough, the last two cells meant for the *inḥirāf* and the longest day are left blank for all localities. In the case of Najaf, except the name all other cells are empty. The argument is given only in the first circle, to the right of the vertical diameter. The gazetteer is read from the top centre in anti-clockwise direction, from right to left.

Table A001-3 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
1	Makka Mubārak	77;10	21;40
2	Madīnat Rasūl	75;20	25;0
3	Bayt al-Maqdis	66;30	31;50
4	Iskandariyya	61;54	30;18
5	Miṣr	63;20	30;20
6	Dimashq	70;0	33;15
7	Ḥalab	77;10	35;50
8	Qusṭanṭiyya	59;50	45;0
9	Marāgha	82;0	37;20
10	Tabrīz	82;0	38;0
11	Ardabīl	82;30	38;0
12	Shamākhī	84;30	40;50
13	Kūfa	79;30	31;30
14	Baghdād	80;30	33;25
15	Baṣra	84;0	30;0
16	Shīrāz	88;0	29;36
17	Hamadān	83;0	35;10
18	Sāwa	85;0	35;0

	Place Name	L	φ
19	Qazwīn	85;0	36;15
20	Iṣfahān	86;40	32;25
21	Kāshān	86;0	34;0
22	Qum	84;40	34;45
23	Rayy	86;20	35;00
24	Astarābād	89;35	36;50
25	Samnān	88;0	36;0
26	Damghān	88;50	36;20
27	Bisṭām	89;30	36;20
28	Shīrwān	91;30	36;0
29	Nishābūr	92;30	36;21
30	Ṭūs	92;30	37;0
31	Turshīz	92;0	35;0
32	Ṭabas Gīlakī	92;0	33;0
33	Tūn	92;30	34;30
34	Qā'īn	93;20	31;40
35	Harān	94;20	34;30
36	Bādhghīs	94;30	20;35
37	Sarkhas	94;30	37;0
38	Marw	97;0	37;40
39	Fariyāb	99;0	36;45
40	Balkh	80;0	36;41
41	Khujand	105;35	41;15
42	Ṭāliqān	102;50	36;25

	Place Name	L	φ
43	Narjisat ?	104;25	36;10
44	ᶜĀrā	97;30	39;50
45	Samarqand	99;16	40;0
46	Kashghar	106;0	44;0
47	Chīn ?	125;0	24;0
48	Banjahīr	104;40	35;0
49	Mūltān	106;35	29;40
50	Qandahār	106;40	33;0
51	Dihlī	113.35	28;15
52	Kashmīr	108;0	35;0
53	Lāhūr	109;20	31;50
54	Kannawj	105;50	26;35
55	Nahlawāra	102;30	27;0
56	Sawmnāt	107;10	22;15
57	Sarandīb	104;0	10
58	Mansūra Sind	104;0	27;40
59	Hurmūz	92;0	24;0
60	Ḥims	69;40	34;0
61	Qulzum	66;30	28;0
62	ᶜAdan	70;0	11;0
63	Ṣanaᶜā’ az Yaman	70;0	14;30
	Inner Circle		
64	Hajar Baḥrayn	83;0	25;35
65	Qaṭif Baḥrayn	72;0	22;0

	Place Name	L	φ
66	Jazīraat Ḥarrān	73;0	36;40
67	Mosul	77;0	36;30
68	Bardaᶜ	83;0	40;0
69	Bulghār	79;0	34;0
70	Shūstar	84;30	31;30
71	Yazd	89;0	32;0
72	Sāriya	88;0	36;0
73	Jurjān	90;0	36;15
74	Iṣṭakhr	88;30	35;0
75	Dhābid	74;20	14;10
76	Tubbat	110;0	40;0
77	Akra	93;0	27;39
78	Bandar Tāna	84;5	19;20
79	Kajmakarān	99;0	28;0
80	Sirjān	90;20	39;30
81	Suhraward	83;20	37;0
82	Kāzrūn	87;0	29;0
83	Khuway	79;6	37;40
84	Bandar Qulzum	64;0	29;0
85	Ṣuḥār ᶜAmān	84;0	14;20
86	Baᶜalbak	70;45	33;15
87	Akhlāṭ	75;45	29;20
88	Madā’īn	72;0	33;10
89	Laḥasā	83;30	24;0

	Place Name	L	φ
90	Wāsiṭ	81;30	32;20
91	Andarāb	103;45	36;0
92	Tā'īf	77;30	21;20
93	ᶜĀbān	84;30	30;0
94	Lār	90;0	28;0
95	Najaf	—	—

BACK

On the back, the upper half of the rim is graduated, as in the front, in groups of 5° and then in single degrees. The former are labelled in *abjad* notation from 5° to 90° and then from 90° to 5° (5—90; 90—5). These are the scales of altitude.

The back is divided into four quarters. In the upper left quadrant, there is a trigonometric grid with 60 horizontal parallels. Every tenth of these is extended into the upper right quadrant as a quarter circle, to form a solar quadrant there, with a quarter circle for each 30° of solar longitude or one zodiacal sign. The signs are labelled along the vertical and horizontal radii by their serial numbers (0 for Aries, 1 for Taurus and so on). Thus the numbers engraved along the vertical radius from the centre up to the circumference are 3 to 8, i.e. summer solstice to winter solstice; those engraved along the horizontal axis from the circumference up to the centre are 9 to 11; 0 to 2, i.e. from winter solstice to summer solstice.

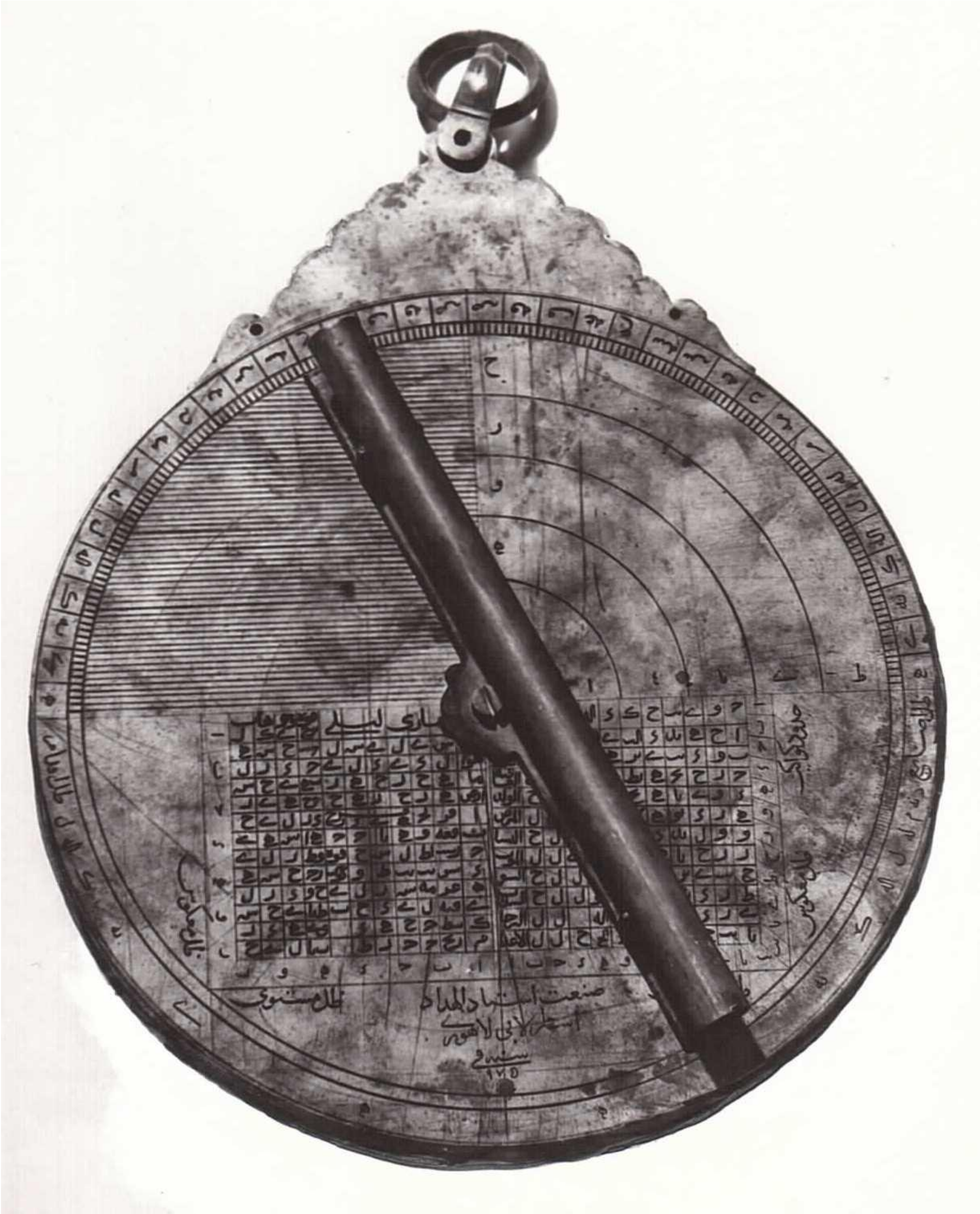

Figure A001.5 – Back of the astrolabe (photo courtesy Salar Jung Museum)

In the two lower quadrants are engraved the shadow squares. The square on the left is for the gnomon of 7 feet. The vertical scale is divided in 7 parts and numbered from 1 to 7 starting from the horizontal diameter of the astrolabe; it has the label *ẓill maᶜkūs* (umbra versa or reverse shadow). The horizontal scale is divided in 7 parts and numbered from the centre onwards; it carries the legend *ẓill mustawī* (umbra recta or direct shadow).

The square on the right is for the gnomon 12 digits. The vertical scale is divided in 12 parts and numbered from 1 to 12 starting from the horizontal diameter of the astrolabe; it has the label *ẓill maᶜkūs* (umbra versa or reverse shadow). The horizontal

scale is divided in 12 parts and numbered from the centre onwards; it carries the legend *ẓill mustawī* (umbra recta or direct shadow).

Inside these shadow squares is a rectangular grid containing four astrological tables. This rectangular arrangement is exactly the same in the next astrolabe (0). The four astrological tables will be discussed there.

The lower half of the rim carries the two cotangent scales and their subdivisions. The scale on the left is in feet; the unequal divisions are numbered from the meridian onwards anti-clockwise as 5, 10, 15, … 40, 45, 50, followed by the label *ẓill aqdām* (shadows in feet). The scale on the right is in digits; the unequal divisions here numbered as on the left, clockwise from the meridian onwards, followed by the label *ẓill aṣābi*^{c} (shadows in digits).

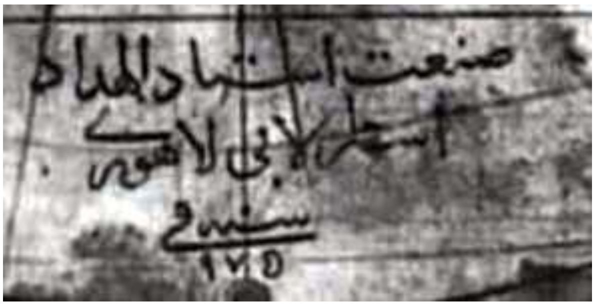

Figure A001.6 – Signature of the astrolabe maker (detail from Figure A001.5) –

INSCRIPTION

The maker's inscription is engraved below the shadow squares in three lines:

ṣan^{c}*at ustād allāhdād*

asṭurlābī lāhūrī

fī sanah 975

'Made by Master Allāhdād, the astrolabe maker of Lahore, in the year 975 [Hijrī = 1567-68 AD].'

ALIDADE, PIN AND HORSE

The original alidade, pin and horse are missing. Now there is a straight alidade with turtle-head-shaped ends and a five-lobed centre piece. A cylindrical sighting tube

is attached to the sights. The pin and the horse are replaced by a modern bolt and a wing nut.[176]

BIBLIOGRAPHY

Sarma 1996, pp. 7-11, pls. 1-3.

176 In fact, all the six astrolabes at the Salar Jung Museum are equipped with the same type of alidades with sighting tubes, bolts and wing nuts. It appears that all the six astrolabes were acquired from a single dealer who may have added these modern replacements to the astrolabes.

A002⊙ ASTROLABE BY ALLĀHDĀD, NOT DATED

Not dated, late 16th century, Lahore

Diameter 255 mm

Oxford, Museum of the History of Science (# 47376)

CCA 1089; Répertoire 2

Figure A002.1 – Front of the astrolabe
(© Museum of the History of Science, Oxford)

This is a massive astrolabe with a diameter of 255 mm and a thickness of 14 mm; the *kursī* and rete are elegantly crafted with matching floral design.

COMPONENTS

Body with crown (d. 255, h. 317, t. 14) with shackle and ring, rete (d. 229) for 36 stars, 6 plates (d. 229), alidade (230, w. 16, t. 4), pin, wedge, rule.

FRONT

A very massive ring with diamond-shaped cross-section and sharply pointed edges, smaller shackle also with diamond-shaped cross-section; seen from the side the shackle has the trifoliate form, the bases of the shackle are circular and plain.

The crown is elegantly reticulated with fine decorative lines engraved on the surface. There are decorative lines at the back also. On the edge of the main body are engraved alternately long and short cartouches, probably for an inscription but are not filled in. General pattern of decorations on the crown and rete consists of tulips with two or three petals.

On the limb is engraved the degree scale in three bands. In the outer band, groups of 5° are marked and numbered in 5s from 5 to 360 in *abjad* symbols. The two inner bands are divided in single degrees. Probably the innermost band was intended to be divided into three parts of twenty minutes each, but this was not done. On the back, the upper half of the rim is also calibrated in this manner, but at the bottom of the upper right quadrant, the innermost band is divided into 20 minutes each in the first unit of 5°.

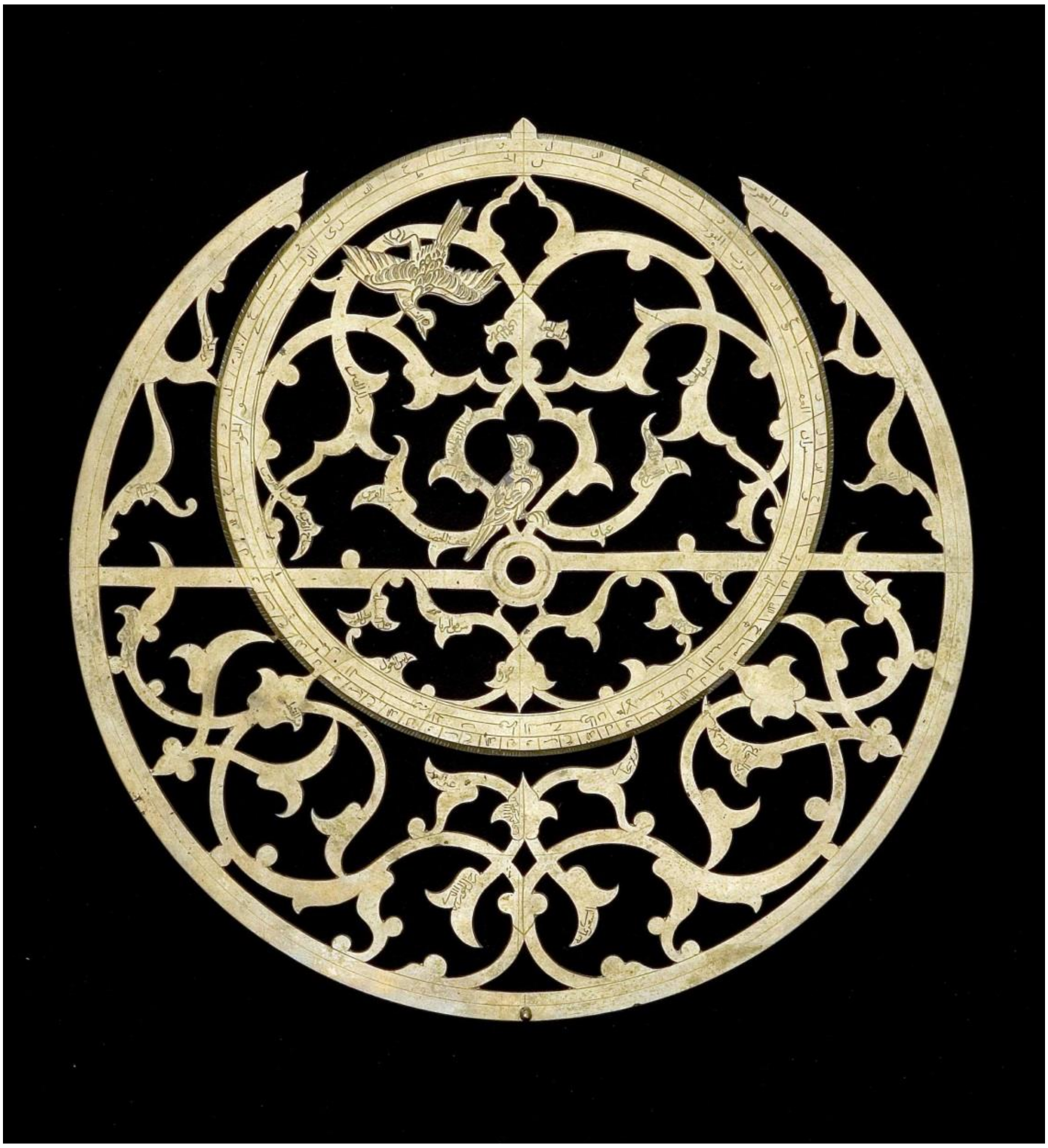

Figure A002.2 – Rete of the astrolabe (© Museum of the History of Science, Oxford)

RETE

The rete is constituted by the two rings of Capricorn and ecliptic which are held together by the equinoctial bar which is counter-changed at the centre. The equator is not represented. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names, starting from the vernal equinox and proceeding counter-clockwise. Each sign is divided into groups of 6° and numbered as 6, 12, 18, 24, 30 also proceeding counter-clockwise. The sloping edge of the ecliptic circle is marked with the divisions of 1°.

The star pointers are shaped like the flared petals of tulip flowers which are joined by a very elegant floral arabesque tracery. The floral tracery in the rete and a matching design of the openwork *kursī*, which became the hall mark of the Lahore astrolabes, has

its beginnings in this astrolabe. On the rete, the two stars Vega and Altair are shown by cut-out and engraved figures of birds; the former seated and the latter soaring. The outstretched wings of Altair are filled with deeply cut lines so that a series of feathers can be seen. These birds are decorated also at the back with engraved lines.[177]

There is a small handle at the north point on the Capricorn ring. A small triangular projection on the ecliptic ring represents *al-murī,* the zero point of Capricorn.

Figure A002.3 – Detail of Figure A002.2 showing the zoomorphic representation of α Lyrae (Vega) and α Aquilae (Altair)

Listed below are the stars shown on the rete in the order of their increasing right ascension.

177 Later on, Muḥammad Muqīm, one of his two grandsons, would be filling the rete of his astrolabe with more than two dozens of similar cut-out figures of zoomorphic star pointers in A049.

Table A002-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab Qayṭus Janūbī*	β Ceti
2	*Baṭn al-Ḥūt*	β Andromedae
3	*Rijl al-Musalsala*	γ Andromedae
4	*Fam al-Qayṭus*	γ Ceti
5	*R'as al-Ghūl*	β Persei
6	*Mirfaq al-Thurayyā*	α Persei
7	*ᶜAyn al-Thawr*	α Tauri
8	*ᶜAyyūq*	α Aurigae
9	*Rijl al-Jawjā' al-Yusrā*	β Orionis
10	*Yad al-Jawjā' al-Yumnā*	α Orionis
11	*Al-Shi ᶜrā Yamānī*	α Canis Majoris
12	*Mirzam Saḥābī*	β Canis Minoris
13	*Fard al-Shujāᶜ*	α Hydrae
14	*Qalb al-Asad*	α Leonis
15	*Ẓahr al-Asad*	δ Leonis
16	*Al-Ṣarfa*	β Leonis
17	*Janāḥ al-Ghurāb*	γ Corvi
18	*Al-Simāk al-Aᶜzal*	α Virginis
19	*ᶜAnāq*	ζ Ursae Majoris
20	*Al-Simāk al-Rāmiḥ*	α Bootis
21	*Nayyir al-Fakka*	α Coronae Borealis
22	*ᶜUnuq al-Ḥayya*	α Serpentis
23	*Qalb al-ᶜAqrab*	α Scorpii
24	*R'as al Ḥawwā'*	α Ophiuchi

	Star Name	Identification
25	*R'as al Jāthī*	α Herculis
26	*Al-Nasr al-Wāqi*[c]	α Lyrae
27	*Minqār al-Dajāja*	β Cygni
28	*Al-Nasr al-Tā'ir*	α Aquilae
29	*Dhanab al-Dulfīn*	ε Delphini
30	*Dhanab al-Dajāja*	α Cygni
31	*Dhanab al-Ḥūt*	α Gruis
32	*Mankib al-Faras*	β Pegasi
33	*Matn al-Faras*	α Pegasi
34	*Janāḥ al-Faras*	γ Pegasi
35	*Dhanab al-Jadī*	δ Capricorni
36	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are six plates of varying thickness with the following specifications.

Table A002-2 Plates

	φ	longest day	(locality)
1a	21;40°	13;20 hours	(Mecca)
1b	30°	13;57 hours	
2a	33;25°	14;12 hours	(Baghdad)
2b	34;30°	14;20 hours	
3a	37°	14;32 hours	
3b	38°	14;40 hours	
4a	39;37°	14;50 hours	(Samarqand)

	φ	longest day	(locality)
4b	45°	14;27 hours!	
5a	27°	13;43 hours	(Agra ?)
5b	Tablet of horizons (western type)		
6a	Tablet of ecliptic coordinates		
6b	Universal plate for all latitudes designed by Ibn-Bāṣo		

As in the other astrolabe by Allāhdād (A001), the plates in this astrolabe are locality specific rather than latitude specific.[178] On these, altitude circles are drawn for each 1°, every third circle is interrupted once on both sides of the meridian and its serial number is engraved in the space created by the interruption. This is a unique feature; in other astrolabes the numbers are written in the spaces between the lines; here the numbers form a semi-circular arc and not the rounded figure of M as in the other astrolabes. No lines are highlighted.

The azimuth circles are drawn for every 6° below the horizon and numbered along the equatorial circle. Lines are drawn for seasonal hours and for equal hours drawn from the western horizon as well as from the eastern horizon, both reaching up to the meridian, but numbered from the western horizon. In plate 4a equal hours are not numbered.

Under the intersection of the oblique horizon and the prime vertical on the west is written *al-maghrib* and in the east *al-mashriq.* Below the horizon is engraved on either side of the meridian the latitude and the duration of the longest day, but both inscriptions

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178 Four plates (1a, 1b, 2a, 3b) in this astrolabe are common to those in the astrolabe at Hyderabad (A001). In other plates, there are certain differences. In the Hyderabad astrolabe there is a plate for 28;20 (probably Delhi); here there is a plate for 27 (Agra?). At Hyderabad there is a plate for 34°, here for 34;30. In three cases, the durations of the longest day differ.

37°	Hyderabad	14;37	Oxford	14;32
39;37°	Hyderabad	14;52	Oxford	14;50
45°	Hyderabad	15	Oxford	14;27.

In the tablet of horizons at Hyderabad, half-horizons are engraved in four sets; here in eight sets.

are in a single line and not in two lines as in other astrolabes. Thus on plate 1a, there is *al-arḍ k-a-m* and *al-sa*^c*āt y-j k.*

On all plates calibrated for a particular latitude, the horizon lines, the prime meridian and the lines of equal hours are inlaid with silver wire. On plate 5a for 27°, the prime meridian is shown only below the horizon; on other plates, it is shown as a full circle extending above and below the horizon.

On plate 5b is engraved a tablet of horizons of the western type. On 6a is the tablet of ecliptic coordinates and on 6b there is a universal plate which was designed by Ibn Bāṣo.

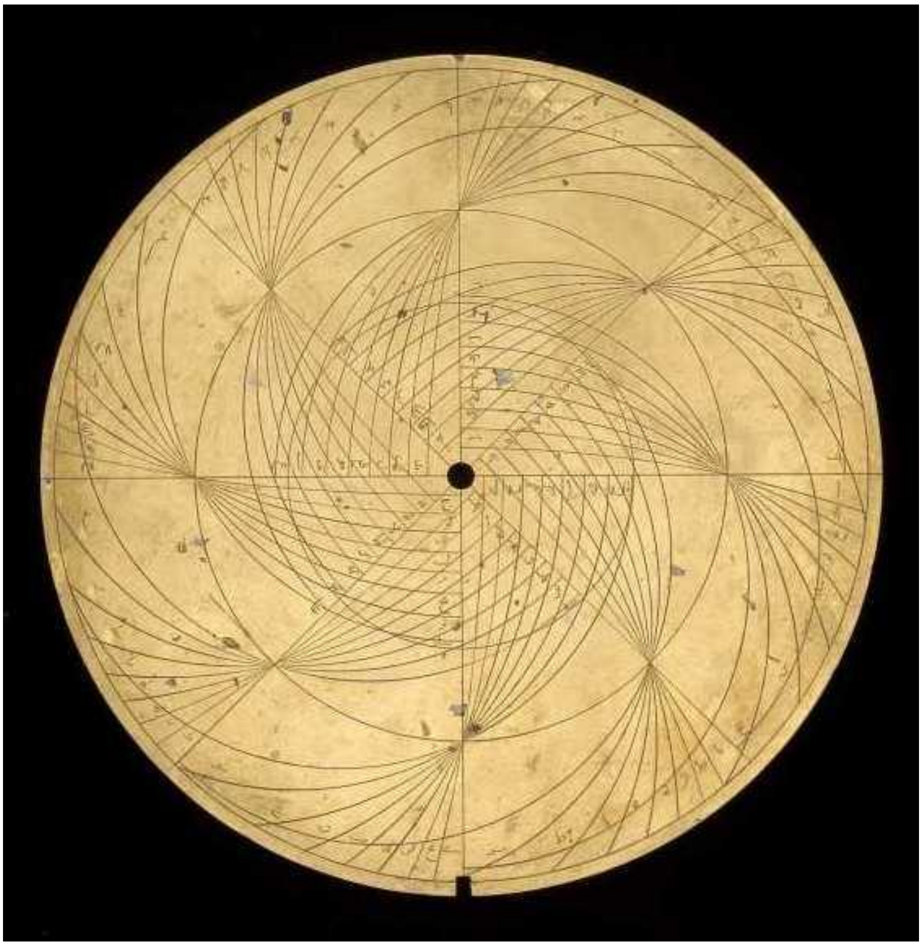

Figure A002.4 – Tablet of horizons (© Museum of the History of Science, Oxford)

5a. Tablet of Horizons

While Allāhdād's other astrolabe (A001) contains a tablet of horizons of the eastern type, this astrolabe has a tablet of horizons of the western type where the half-horizons are arranged in eight groups. The horizons for latitudes ranging from 8° to 71° are arranged at intervals of 8° in eight batches in the following manner:

8	16	24	…	48	56	64
9	17	25	…	49	57	65
10	18	26	…	50	58	66
11	19	27	…	51	59	67
12	20	28	…	52	60	68
13	21	29	…	53	61	69
14	22	30	…	54	62	70
15	23	31	…	55	63	71

The horizons are numbered at both their extremities, i.e., at the periphery of the plate and at the radials drawn from the centre. There are no declination scales, nor is there a label on the plate. This is the only case of western type of the tablet of horizons in Indo-Persian astrolabes.

6a. Tablet of ecliptic coordinates

On this plate are drawn the equator, the ecliptic and the two tropics. The ecliptic circle is inlaid with silver. Concentric circles of ecliptic latitudes (= altitude circles for the latitude of 90° – obliquity) are drawn for every 5° and numbered on both sides of the meridian.

Arcs of ecliptic longitudes (= azimuth arcs for the latitude of 90° - obliquity) radiating from the centre are drawn for every 5°. Every sixth of these arcs is inlaid with silver, these constituting the boundaries of the twelve signs of the zodiac. But the names of the signs are not written along the circumference of the ecliptic; instead groups of 5° (of azimuth/ celestial longitude) are numbered along its entire circumference 5—90; 90—5; 5—90; 90—5.

There is no label on the plate. This occurs in most of the Lahore astrolabes.

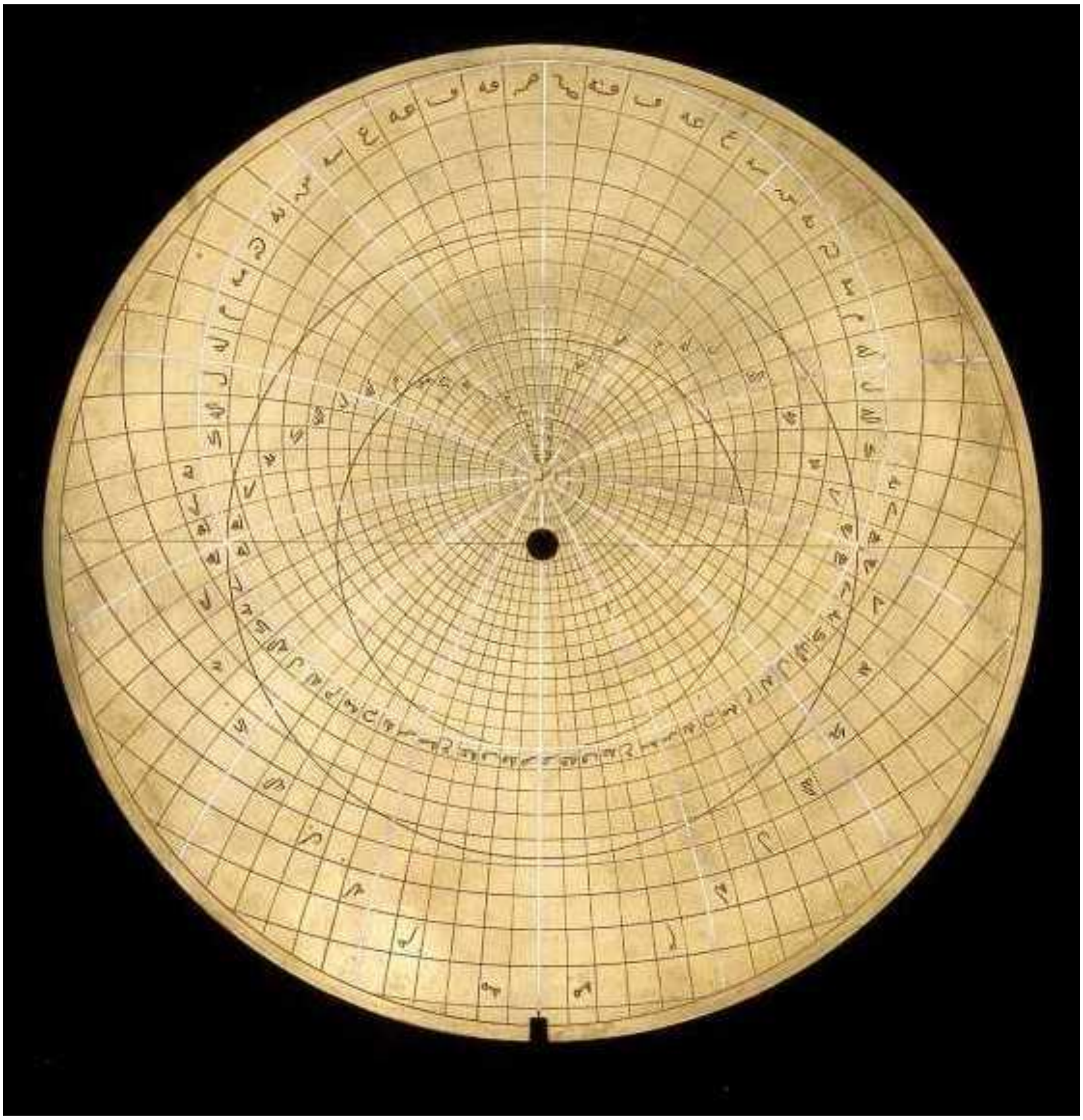

Figure A002.5 – Tablet of ecliptic coordinates (© Museum of the History of Science, Oxford)

6b. Universal plate for all latitudes

On the reverse side of the tablet of ecliptic coordinates is engraved a universal plate for all latitude which was designed by Ibn Bāṣo in the thirteenth century in Andalusia.[179] It combines the features of the latitude plate (*ṣafīḥa*) and the tablet of horizons. On this plate are drawn three families of circles.

First, there is a series of 30 arcs of great circles passing through the east and west points. These are horizons for each 6° of terrestrial latitudes from +90° to -90°. These are not numbered.

[179] On Ibn Bāṣo, see Calvo 2007; on the construction and use of the universal plate, see Calvo 2000.

Then around the east and west points are drawn 15 arcs each at 6° intervals. These arcs divide horizons into equal parts. The outermost arcs are inlaid with silver. The numbers of these arcs start from the east and west points and proceed along lower periphery up to the meridian line.

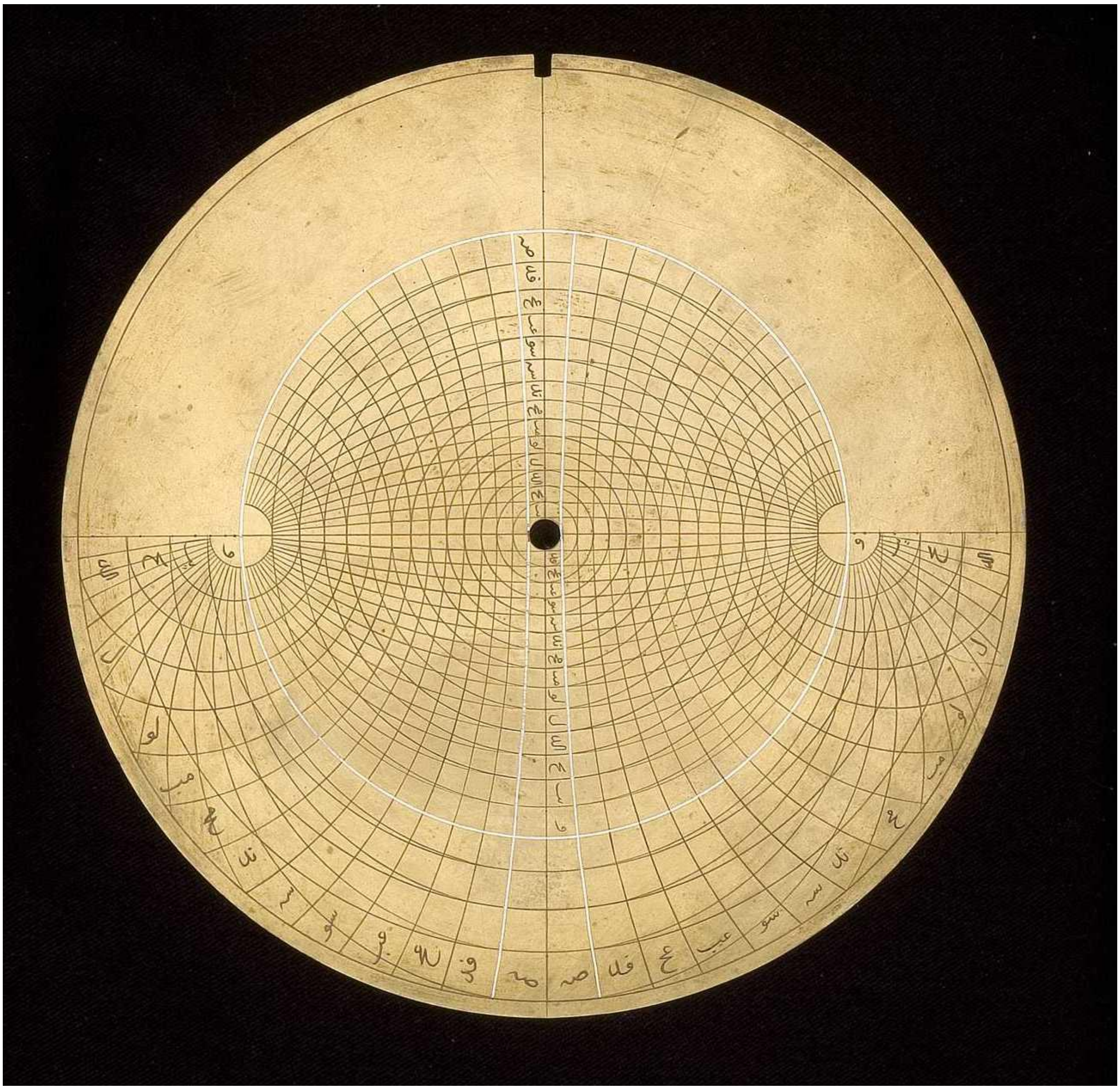

Figure A002.6 – Universal plate after Ibn Bāṣo
(© Museum of the History of Science, Oxford)

Third, around the centre are drawn 14 concentric circles at 6° intervals. These are altitude circles for the latitude of 90°. Ibn Bāṣo calls them *madārāt* (parallels of declination). These circles are numbered along the vertical diameter both above and below the centre. Above from 6 up to 90 at the centre, and again from 6 at the centre to 90 below. The outermost circle here, which is the projection of the equator, is inlaid with silver.

Between this circle of the equator and the outer circle of the plate are drawn three semi-circles, only in the northern half. These are called by Ibn Bāṣo *anṣāf dawā'ir al-mayl* (semicircles of declination).

There is no label on this plate either. In an unsigned which can be attributed to Allāhdād and which will be described next (A003), there is a similar plate which bears the label *al-ṣafīḥa al-jāmi*[c]*a li-jāmī*[c] *al-*[c]*urūḍ* (universal plate for all latitudes).

GEOGRAPHICAL GAZETTEER

The geographical gazetteer is engraved in three concentric circles, providing the name (*al-bilād*), longitude (*al-ṭūl*), latitude (*al-arḍ*), *inḥirāf* (*al-inḥirāf*) and the longest day (*al-arḍ sā*[c]*āt*) in 5 cells situated one below the other for 165 localities.

The cell for the *inḥirāf* is often blank; sometimes it is filled by the maker, some other times by a later hand in smaller and scratchy script. These additions by the different hand are marked bold in the following table. Many cells of the longest days are also not filled, especially for places in the Indian subcontinent. As compared to the previous astrolabe, there are more localities from India (about 20) in this gazetteer. The data is read from the right to the left, starting at the topmost point.

Figure A002.7 – Geographical gazetteer (© Museum of the History of Science, Oxford)

Table A002-3 Geographical Gazetteer

	Place Name	L	φ	*inḥirāf*	Longest Day
	Outer Circle				
1	Makka Mubārak	77;10	21;40	**0;0**	13;20
2	Madīnat Rasūl	75;20	25;0	**36;10**	13;36,33
3	Bayt al-Maqdis	66;30	31;50	29;36	14;50
4	Iskandariya	61;54	30;58	39;36	14;0
5	Miṣr	63;20	30;20	60;24	13;18
6	Dimashq	70;00	33;15	30;16	14;12
7	Ḥalab	72;10	35;50	**34;10**	14;26,27
8	Qusṭanṭiyya	59;50	45;0	38;0	15;14,27
9	Marāgha	82;0	37;20	15;50	14;32
10	Tabrīz	82;0	38;15	15;30	14;42
11	Ardabīl	82;30	38;30	15;30	14;42
12	Shamākhī	82;30	40;50	**15;30**	14;16,38
13	Kufa	79;30	31;30	**12;31**	14;3,43
14	Baghdād	80;0	33;25	13;0	14;3
15	Baṣra	84;0	30;0	18;24	13;12
16	Shīrāz	88;0	29;36	11;23	13;15
17	Hamadān	88;0	35;10	25;30	14;24
18	Wah	85;0	35;0	29;14	14;29
19	Qazwīn	85;0	36;15	26;30	14;30
20	Iṣfahān	86;40	32;25	40;23	14;9
21	Kāshān	86;0	34;0	36;8	14;19
22	Qumm	85;40	34;45	**32;13**	14;24
23	Rayy	86;20	35;0	**31;33**	14;24

	Place Name	L	φ	*inḥirāf*	Longest Day
24	Tā’īf	87;30	21;20	—	13;18,15 !
25	Samnān	88;0	36;0	39;40	14;30
26	Damghān	88;50	36;30	28;30	14;31
27	Bisṭām	89;30	36;10	36;30	14;30
28	Sabzwār	91;30	36;5	38;42	14;30
29	Nīsābūr	92;30	36;21	45;3	14;31
30	Ṭūs	92;30	37;0	45;45	14;30
31	Turshīz	92;0	35;0	48	14;21,50
32	Tabas Gilakī	92;0	33;0	12;0	14;12
33	Tūn	92;30	34;30	**12;3**	14;19,9
34	Qā’īn	93;20	31;40	**12;1**	14;15!
35	Herāt	94;20	34;30	13;50	14;21!
36	Badᶜās	94;30	35;20	—	14;25
37	Sarhan?	94;30	34;0	**51;57**	14;19
38	Marw	94;0	37;40	50;45	14;40
39	Fāriyāb	99;0	36;45	—	14;32
40	Balkh	100;0	36;40	54;30	14;32
41	Khujand	105;35	41;55	45;0	14;16!
42	Tāliqān	102;50	36;25	**29;33**	14;31
43	Badakhshān	104;25	36;10	**65?**	14;30
44	Bukhārā	97;30	39;50	14;30	14;49
45	Samarqand	99;16	40;0	49;0	14;12!
46	Kāshghar	106;30	44;0	14;25	15;3
47	Chīn Banjū	125	24;0	75;45	13;25

	Place Name	L	φ	*inḥirāf*	Longest Day
48	Banjahir	104;40	35;0	—	14;29
49	Multān	106;35	29;40	80;43	13;15
50	Qandahār	106;40	33;0	**75;0**	14;12
51	Dehlī	115;45	28;15	86;26	13;48
52	Kashmīr	108;0	35;0	68;12	14;29
53	Lāhūr	109;20	31;50	—	14;5
54	Qannawj	115;50	26;35	—	—
55	Nahlawara	102;30	22;0	45;30	12;28
56	Swmmnāt	103;10	22;15	66;30	12;39
57	Sarandīb	130;0	10;0	18;0	12;13
58	?	104;0	22;40	—	13;43
59	Hurmūz	92;0	24;0	78;45	13;39
60	Ṭārabulus	69;40	34;0	78;12	14;20
61	Qulzum	66;30	28;4	**86;3**	13;48
62	ᶜAdan	76;0	11;0	5;50	12;16
63	Sanaᶜān Yaman	74;0	14;30	**1;15**	—
64	Zabīl	74;20	14;10	**24;25**	—
65	Qaṭif Baḥrayn	72;0	22;0	—	12;38
66	Harrān Jarīna	73;0	36;40	—	14;32
67	Mawṣil	77;0	36;30	**3;54**	14;31
68	Bardaᶜ	83;0	40;0	**16;36**	14;12!
69	Bulghār	79;0	34;0	—	14;20
70	Shushtar	84;30	31;30	35;20	14;3,43
71	Yazd	89;0	32;0	44;14	14;5

	Place Name	L	φ	*inḥirāf*	Longest Day
72	Sāriya	88;0	35;0	**34;54**	14;29
73	Jurjān	90;0	36;45	36;15	14;34
74	Iṣṭakhar	88;30	35;0	—	14;29
75	Tubbat	110;0	40;0	—	14;12/52
76	Laḥasā	83;30	24;0	**69;30**	13;39
77	Akra	93;0	27;36	**45;3**	13;43
78	Bandar Tāna	104;5	19;20	—	—
79	Kach Kamrān	99;0	28;0	—	13;48
80	Sīrkhān	90;20	29;30	59;0	13;55!
81	Suhraward	83;20	37;0	—	—
82	Kāzirūn	87;0	29;15	**51;57**	13;14
83	Khuway	79;40	37;40	**18;3**	14;40
84	Bandar Qulzum	64;0	29;30	—	13;15
85	Ṣuhār ᶜAmān	84;0	14;20	**40;32?**	—
86	Baᶜalabak	70;45	33;15	—	14;12
87	Akhlāṭ	75;85!	39;20	—	—
88	Madā'īn	77;0	33;10	28;1	14;12
89	Baghdād	80;0	33;25	13/20;0	14;13
90	Wasit	81;30	32;20	**20;57**	14;8
91	Baṣra Mᶜaran (?)	70;0	32;0	—	14;5
92	Andarāb	103;45	36;0	—	14;30
93	Abādān	84;45	36;0	—	13;14/2
94	Jand Nīsābūr	85;0	33;0	**62;9**	14;12
95	ᶜAskar (?) Mukrām	84;30	31;55	—	14;5

	Place Name	L	φ	*inḥirāf*	Longest Day
	Middle Circle				
96	Astarābād	89;35	36;50	36;3	14;24
97	Lār Sarār	90;0	28;0	66;30	13;48
98	Najaf	**?;15**	**32;5**	**14;34**	—
99	Ḥilla	79;15	32;15	32;40	14;7
100	Karbalā	**83;55**	**32;40**	**14;0**	—
101	Jadda	76;30	21;45	—	13;21
102	Sardārmanī	79;45	34;52	**200;85!**	14;25
103	Madīnat Sanā (?)	77;0	14;0	—	—
104	Bam	94;0	28;30	69;0	13;49,01
105	Dar ab-Charad	90;15	28;15	—	13;48
106	ᶜArnīn	84;20	33;35	**70;0**	14;14,18
107	Abhar	14;30	36;45	**25;0**	14;31,35
108	Ṭāram	84;0	36;30	—	—
109	Sārī	88;0	37;0	—	—
110	Āmal	88;20	36;15	33;21	14;31
111	Damāwand	57;20	36;10	**32;44**	—
112	Sulṭāniyā	83;30	36;36	26;40	14;33
113	Basā	93;30	37;40	—	—
114	Kāshgar	106;30	44;30	15;3	14;25
115	Khotan	107;0	47;0	**20**	—
116	Aḥmadābād	—	—	—	—
117	Khanbāyich	109;10	22;20	—	—
118	Bahroj	102;5	21;20	—	—

	Place Name	L	φ	*inḥirāf*	Longest Day
119	Mandu	110;45	22;35	—	—
120	Qalanjar?	106;0	25;25	—	—
121	Kawaliyār	115;35	26;33	—	—
122	Bānāras	117;20	26;15		
123	Munkher	119;10	22;0	—	—
124	Chanlawa?	121	22	—	—
125	Manārkānū?	124;0	22;0		
126	Kulbarkā	109;11	17;40		
127	Bījāpūr	108;30	17;20		
128	Bīdar	110;13	33;35!		
129	Aḥmadnakar	—	—	—	—
130	Dābal	—	—	—	—
131	Juyūl	106	19;0	—	—
132	Dawlatābād	—	—	—	—
133	Tālankānd	—	—	—	—
134	Dībal	80;30	38;0	—	—
135	Kābul	104;40	34;30	**70;37**	—
136	Arna	104;20	33;25	—	—
137	Ahwāz	84;0	31;0	—	—
138	Jazīra …	84;30	33;0	—	—
139	Fīrūzābād	87;30	28;10	—	—
140	Dīnūr	83;0	35;0	22;31	—
141	Bākuna	84;30	39;30	**20;53**	—
142	Taḥshab	98;0	39;0	—	—

	Place Name	L	φ	*inḥirāf*	Longest Day
	Inner Circle				
143	Abarqū	88;10	31;30	45;0	14;2
144	Kermān	92;30	30;5	63;2	13;18!
145	Sābkārā	89;0	28;28	13;28	13;49
146	Kartān	—	—	34;30	—
147	Husum	15;10	37;0	33;31	14;33,0
148	Sūs	15;30	22;0	74;30	12;38
149	Mūqān	83;0	38;0	38;34	14;39,15
150	Khwārizm	102;0	42;0	14;30	15;7
151	Bajīram?	107;30	26;30	76;15	—
152	Karkān	—	—	39;3	—
153	Qūniya	66;30	40;0	62;16	14;17,13
154	Jarmī Ḥabasha	65;30	9;30	45;0	12;12
155	Lāhjān	86;50	36;25	28;34	14;31
156	Khatlān	37;0	84;10	28;35	14;35
157	Barbar	65;0	14;0	39;10	12;4
158	Arsāhbal	82;0	19;4	39;0	12;12
159	Himṣ	70;45	33;15	—	14;16,28
160	Mārdīn	74;0	37;15	—	14;34,34
161	Khān Bāligh	124;0	46;0	—	14;34,8
162	Khabīṣ	93;0	31;5	—	14;1,16
163	Jīrfat	93;0	27;30	—	13;43
164	Maᶜazar Lambān	24;0	33;40	—	33;25!
165	Naṭīr	86;0	33;15	—	14;12

Baghdād occurs twice at 14 and 89 and Kāshghar at 46 and 114! In as many as 18 cases, the duration of the longest day is given in hours, minutes and also in seconds (see, e.g., nos. 2, 7, 8 and so on).

BACK

The back of the astrolabe is almost the same as in the previous astrolabe, with two minor differences. In the previous astrolabe, the shadow square for 7 is on the left and that for 12 on the right. Here it is the reverse. In the previous astrolabe, the name of the maker is followed by the year of manufacture. Here the year is not mentioned.

The upper half of the rim carries the two altitude scales which are divided in 1° and 5° and numbered as 5—90; 90—5. The lower half of the rim carries the two cotangent scales in feet and in digits respectively.

In the upper left is the trigonometric quadrant with 60 horizontal parallels. There are no labels or dotted lines. In the upper right is the solar quadrant with a declination arc for each 30° of solar longitude or one zodiacal sign. The signs are labelled along the vertical and horizontal radii by their serial numbers (0 for Aries, 1 for Taurus and so on). Thus the numbers engraved along the vertical radius from the centre up to the circumference are 3 (Cancer) to 8 (Sagattarius), i.e. summer solstice to winter solstice; those engraved along the horizontal axis from the circumference up to the centre are 9 (Capricorn) to 11 (Pisces); 0 (Aries) to 2 (Gemini), i.e. from winter solstice to summer solstice.

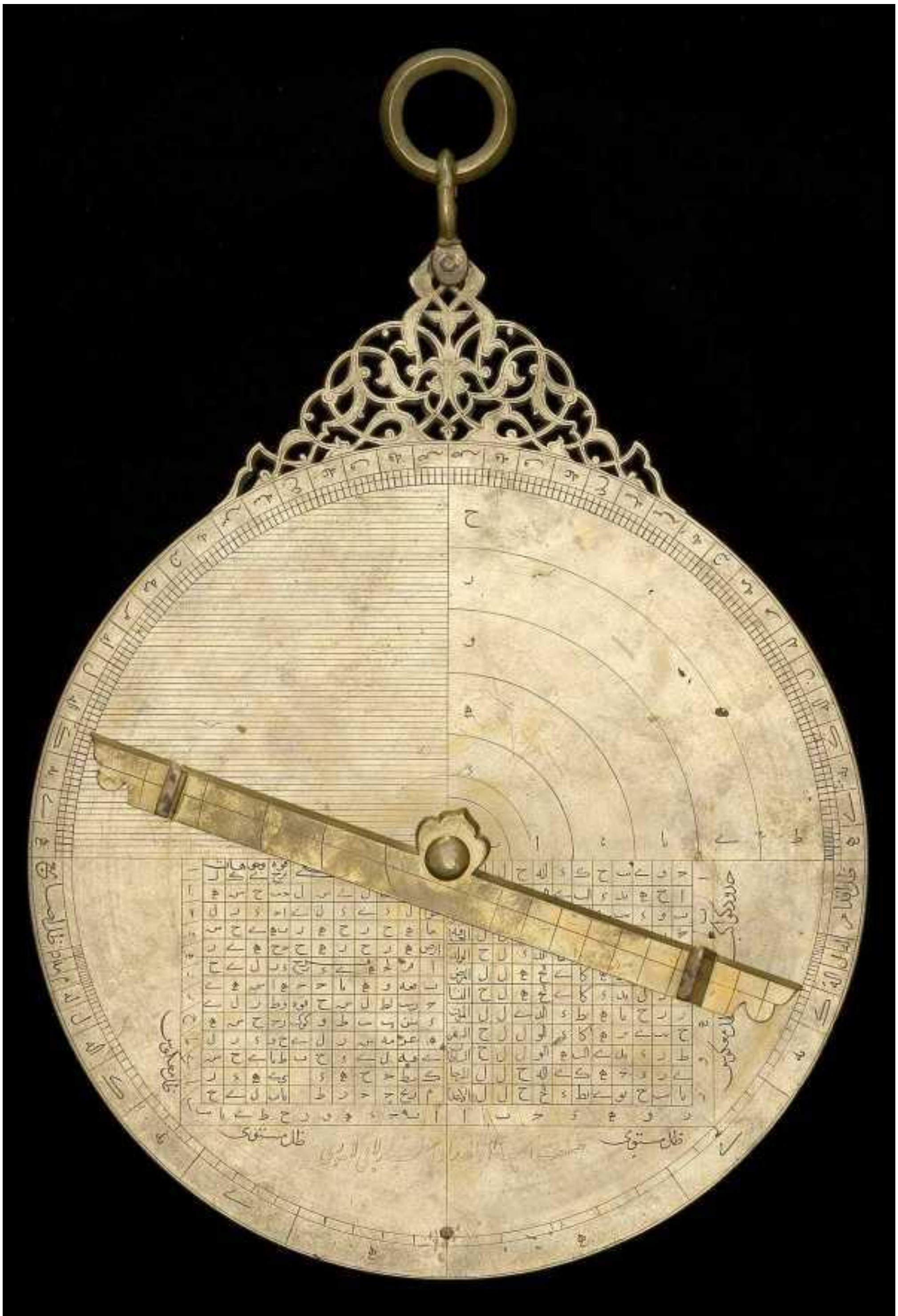

Figure A002.8 – Back of the astrolabe (© Museum of the History of Science, Oxford)

In the lower half are shadow squares, on the left for 12 digitd and on the right for 7 feet.

ASTROLOGICAL TABLES

Inside the shadow squares is a large rectangular grid containing four astrological tables, exactly as in A001.

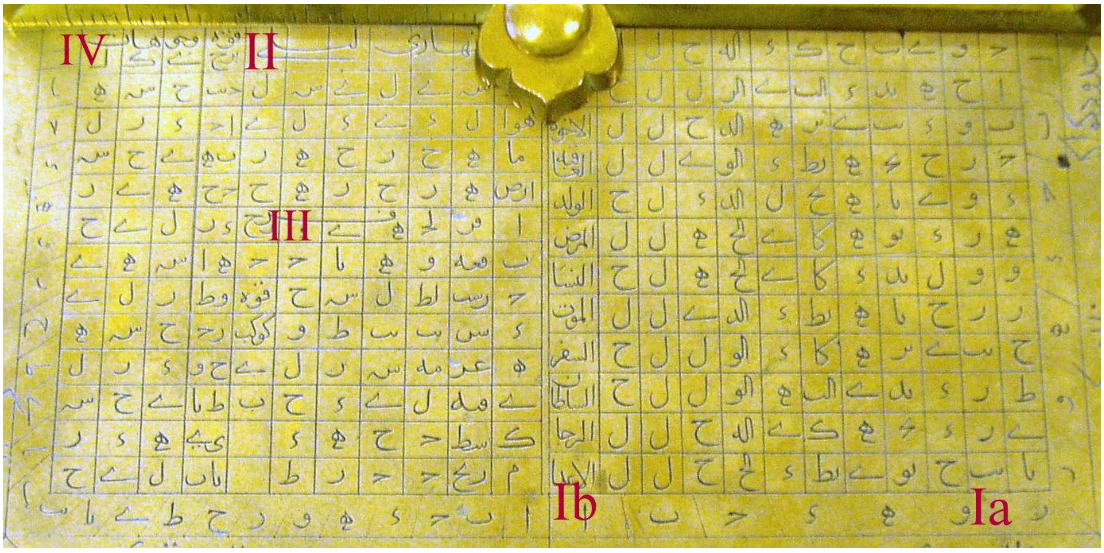

Figure A002.9 – Astrological tables on the back (photo by S. R. Sarma)

Ia Table of limits or terms of the signs (*al-ḥudūd*)

Starting from the right, the first is the table of the limits or the terms of the signs in 11 columns and 12 rows. The corresponding label *ḥudūd kawākib* is engraved on the right hand side, outside the vertical scale of the shadow squares. Here the 30 degrees of each sign are divided into 5 intervals of unequal size and each interval is assigned to a planet other than the sun and moon. In the table here, the first column on the right carries the arguments, namely the 12 signs of the zodiac, represented here by the serial numbers from 0 to 11 in *abjad* notation.[180] Thereafter, alternate columns display the numerical values of the limits in *abjad* and the names of the planets represented by the last letters of their names in Arabic. There are two systems of indicating the intervals, either each interval separately, or the cumulative sum of the all the preceding intervals. The latter system is followed in the present table.

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180 The first cell of the column carries the symbol for "3" instead of "0" by mistake and this mistake is repeated in A001 as well.

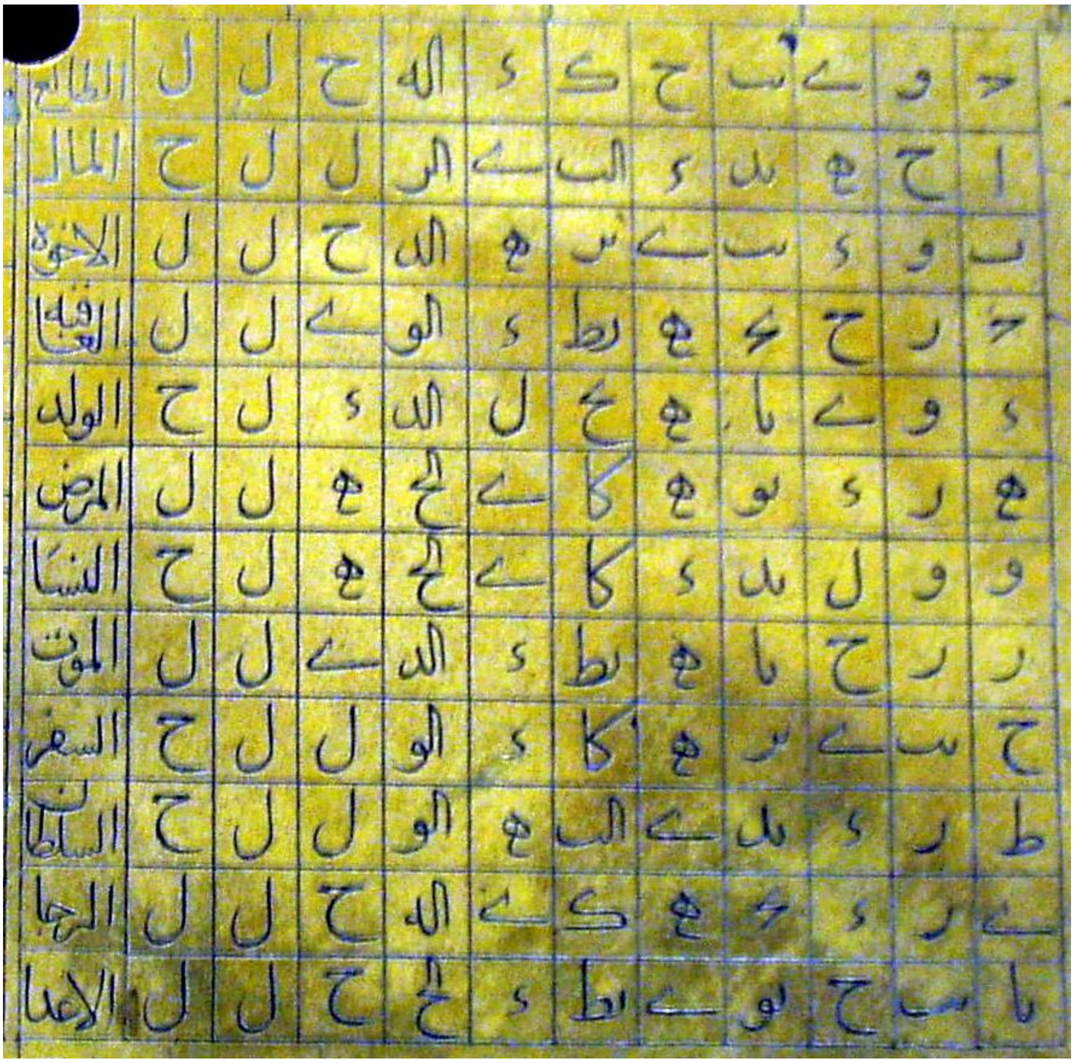

Figure A002.10 – Table of limits (detail of Figure A002.9)

In the following table, instead of the symbols, the full names of the signs and planets are shown.

Table A002-4 Limits of the Signs

0[181]. Aries	6	Jupiter	12	Venus[182]	20	Mercury	25	Mars	30	Saturn
1. Taurus	8	Venus	14	Mercury	22	Jupiter	27	Saturn	30	Mars
2. Gemini	6	Mercury	12	Jupiter	17	Venus	24	Mars	30	Saturn
3. Cancer	7	Mars	13	Venus	19	Mercury	26	Jupiter	30	Saturn
4. Leo	6	Jupiter	11	Venus	18	Saturn	24	Mercury	30	Mars

181 Erroneously 3 in the place of 0.

182 Erroneously Mars instead of Venus.

5. Virgo	7	Mercury	16	Venus	21	Jupiter	26	Mars[183]	30	Saturn
6. Libra	6	Saturn	14	Mercury	21	Jupiter	28	Venus	30	Mars
7. Scorpio	7	Mars	11	Venus	19	Mercury	24	Jupiter	30	Saturn
8. Sagittarius	12	Jupiter	17	Venus	21	Mercury	25	Saturn	30	Mars
9. Capricorn	7	Mercury	14	Jupiter	22	Venus	26	Saturn	30	Mars
10. Aquarius	7	Mercury	13	Venus	20	Jupiter	25	Mars	30	Saturn
11. Pisces	12	Venus[184]	16	Jupiter	19	Mercury	28	Mars	30	Saturn

Ib. In column 13 there are twelve terms which appear to state the influences of the 12 houses of the zodiac on the native's life. These correspond, to a certain extent, to Sanskrit terms. In the following table the Arabic and Sanskrit terms are juxtaposed.

Table A002-5 Houses of the Zodiac

	Arabic Names of the houses of the zodiac	Terms in column 13	Meaning of the previous column	Sanskrit Name	Meaning of the Sanskrit Name
1	*al-ṭālīᶜ*	*al-ṭāliᶜ*	ascendant	*tanu*	body
2	*al-thānī*	*al-māl*	wealth	*dhana*	wealth
3	*al-thālith*	*al-akhwa*	brothers	*sahaja*	siblings
4	*al-rābiᶜ*	*al-ᶜāqiba*	followers?	*suhṛd*	friends
5	*al-khāmis*	*al-wālid*	son	*suta*	son
6	*al-sādis*	*al-marḍ*	sickness	*ripu*	enemy
7	*al-sābiᶜ*	*al-nasā'*	women (pl)	*jāyā*	wife
8	*al-thāmin*	*al-mawt*	death	*mṛtyu*	death
9	*al-tāsiᶜ*	*al-safar*	travel	*dharma*	religious life

[183] Erroneously Venus in the place of Mars.

[184] Erroneously Mars instead of Venus.

	Arabic Names of the houses of the zodiac	Terms in column 13	Meaning of the previous column	Sanskrit Name	Meaning of the Sanskrit Name
10	*al-ᶜāshir*	*al-sulṭān*	ruler	*karma/āspada*	authority
11	*al-ḥādīᶜ ashar*	*al-rakhā’*	welfare	*āya*	income
12	*al-thānīᶜ ashar*	*al-aᶜdā’*	enemy	*vyaya*	Expenditure

II. **The Table of Triplicities** is arranged immediately to the left of the centre at the top in 7 columns and 5 rows. The first row carries the label *muthallathāt nahārī laylī* (triplicities of the day [and] of the night). The characteristics or the elements to which the triplicities are assigned are written in the first column. Here the sequence of the names of the elements is not correctly maintained. Instead of fire, earth, air and water, the engraver wrote fire (*bār*?), air (*hawā*), water (*mā,* more correctly *mā’*) and earth (*arṣ,* correctly *arḍ*). The table contains only the names of the planetary regents. In the reproduction of the table below, the names of the signs are added in square brackets.

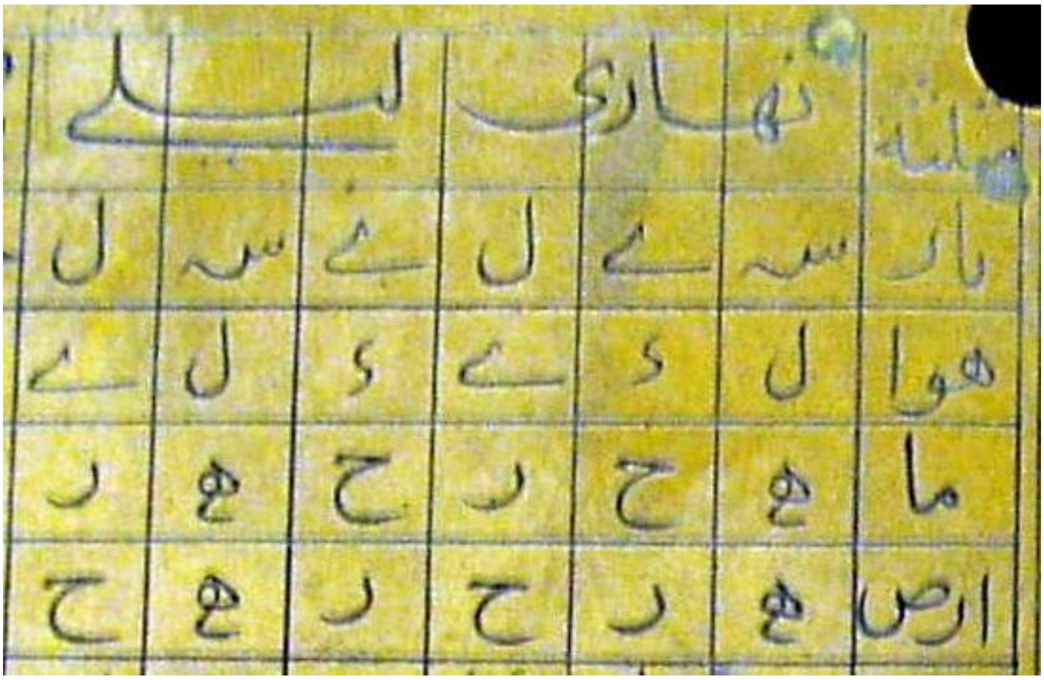

Figure A002.11 – Table of Triplicities (detail of figure A002.9)

Table A002-6 Triplicities

Muthallathāt **triplicities**	***Nahāri*** **of the day**			**Layīlī** **of the night**		
Fiery	[Aries] Sun	[Leo] Jupiter	[Sagittarius] Saturn	[Aries] Jupiter	[Leo] Sun	[Sagittarius] Saturn
Earthy[185]	[Taurus] Saturn	[Virgo] Mercury	[Capricorn] Jupiter	[Taurus] Mercury	[Virgo] Saturn	[Capricorn] Jupiter
Airy[186]	[Gemini] Venus	[Libra] Moon	[Aquarius] Mars	[Gemini] Moon	[Libra] Venus	[Aquarius] Mars
Watery[187]	[Cancer] Venus	[Scorpio] Mars	[Pisces] Moon	[Cancer] Mars	[Scorpio] Venus	[Pisces] Moon

III. Immediately below the tables of triplicities is a table with the intriguing title *farkh* (joy) in 7 columns and 8 rows.

185 Erroneously ‘air’ (*hawā*) instead of ‘earth’.

186 Erroneously ‘water’ (*mā’*) instead of ‘air’. In this and in the next row, Moon and Mars are interchanged in the regents of the day as well as in those of the night.

187 Erroneously ‘earth’ (*arḍ*) instead of ‘water’.

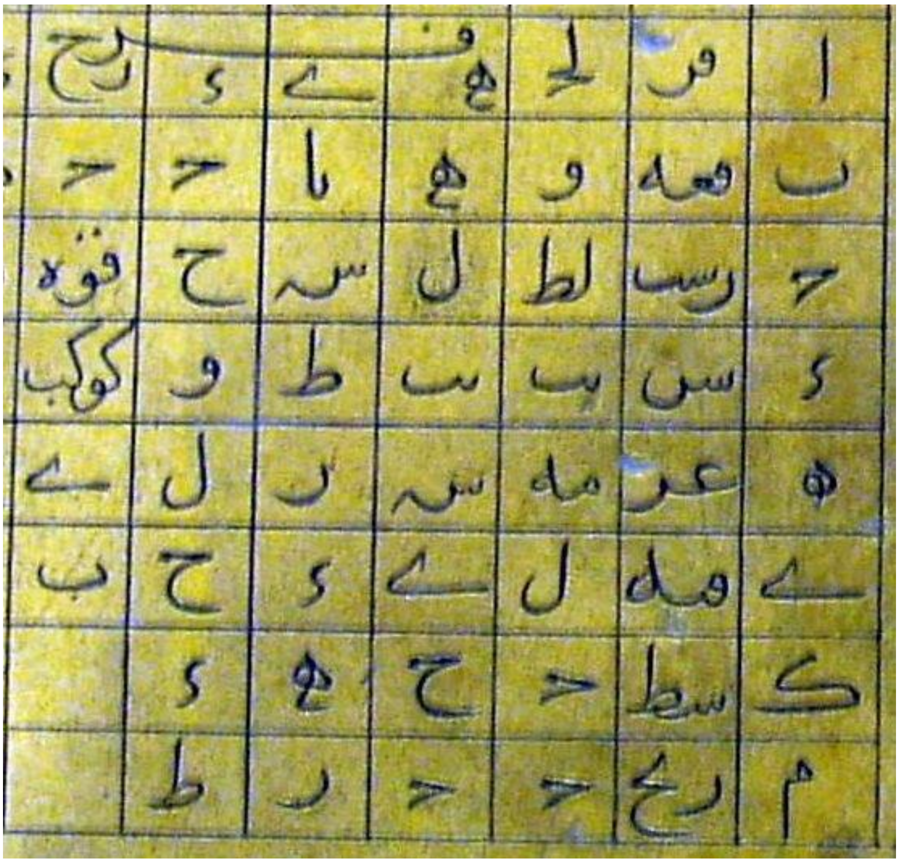

Figure A002.12 – Table of *farkh* (detail of Figure A002.9)

The first column on the right contains obviously the numbers 1, 2, 3, 4, 5, 10, 20, 40 in *abjad* notation. In the rest of the cells, there are alphabetical symbols; it is difficult to decide whether these are mere numerical symbols or symbols for planets. The following table shows both possibilities. Such a table does not occur elsewhere; it is not clear what it signifies.

Table A002-7

1	86/106	13	0/Venus	10/Jupiter	4/Mercury	7/Moon
2	45	6	0/Venus	11	3	3
3	260/ Moon Sun	39	30/Saturn	60/Sun	8/Jupiter	*quwwa*(strength)
4	60/Sun	12	12	9	6	*kawkab*(planet)
5	77	45	60/Sun	7/Moon	30/Saturn	10/Jupiter
10	45	30	10/Jupiter	4/Mercury	8/Jupiter	2
20	69	3	8/Mars	0/Venus	4/Mercury	
40	218	3	3	7/Moon	9	

IV Table of Faces of the Signs (*al-wujūh*)

The last four columns (or the first four when counted from the left) contain a table of decans with the title *wujūhāt* in 4 columns and 12 rows. The first three columns from the left show the planetary regents governing each of the three decans of a sign. The fourth column contains two sets of numbers in *abajd* notation. In the table below, these two sets are reproduced in two separate columns for the sake of clarity. One set has the serial numbers from 0 to 11 and carries the title *burj* (sign); these refer to the 12 signs and form the argument of the table. The second set is problematic. It carries the title *quwwa* (strength);[188] but strength is not usually assigned to the planets governing the decans of signs.

Table A002-8 Faces of the Signs

burj **(sign)**	***Quwwa*** **(strength/ potency)**	***wujūhāt*** **(decans)**		
		10	20	30
0 Aries	8	Mars	Sun	Venus
1 Taurus	12	Mercury	Moon	Saturn
2 Gemini	5	Jupiter	Mars	Sun
3 Cancer	8	Venus	Mercury[189]	Moon
4 Leo	7	Saturn	Jupiter	Mars
5 Virgo	1	Sun	Venus	Mercury[190]
6 Libra	9	Moon	Saturn	Jupiter
7 Scorpio	3	Mars	Sun	Venus
8 Sagittarius	6	Mercury	Moon	Saturn

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188 Dr Martin Gansten informs me that this term became *kuttha* in Sanskrit texts on Tājika astrology which is derived from Arabic/Persian astrology; on these texts, cf. Pingree 1981, pp. 97-100.

189 Erroneously Jupiter instead of Mercury

190 Erroneously Jupiter instead of Mercury

9 Capricorn	11	Jupiter	Mars	Sun
10 Aquarius	10	Venus	Mercury	Moon
11 Pisces	2	Saturn	Jupiter	Mars

Alidade, pin and wedge

The alidade is nicely crafted with ornate terminals and an ornate centre piece. The right half is divided into 12 units, each of which corresponds to 5 divisions in the trigonometric quadrant on the back. The left half is engraved with declintaion arcs to match those in the upper right quadrant on the back. But neither half of the alidade is numbered. The eye-pieces have two holes each, one larger and the other smaller.

The horse is not flat; the head and neck are thicker and contoured. The eyes were originally filled with some red substance which is disappearing. On the neck, the mane is depicted by engraved lines. Plain-headed pin.

Rule in the front

In the front is attached a rule with a pointed end and without any graduations. Indo-Persian astrolabes do not have rules. This one must have been added in recent times.

Figure A002.13 – Signature of the maker (photo by S. R. Sarma)

Inscription

Below the shadow squares is engraved in rather large letters the astrolabe maker's signature in double-outlines:

ṣan^{c}*at ustād allāhdād asṭurlābī lahūrī.*

'Made by Master Allāhdād, the astrolabe-maker of Lahore.'

Provenance

Ex-collection Chadenat; La Ferté-Barnard; coll. J. A. Billmeir, Elstead (Surrey).

BIBLIOGRAPHY

Maddison 1957, No. 159, pp. 20-21, pl. XVIII.

Anderson 1982, Object No. 126, p. 35, fig. 9.

Sarma 1994.

A003$^{\odot}$ ASTROLABE ATTRIBUTABLE TO ALLĀHDĀD

Late 16th century, Lahore

Diameter 208 mm

Oxford, Museum of the History of Science (#34611)

CCA 2530

Figure A003.1 – Front of the astrolabe (© Museum of the History of Science, Oxford)

This astrolabe, though not signed and dated, can be attributed to Allāhdād because of the similarity of workmanship between this astrolabe and the undated astrolabe by Allāhdād (A003) and because these two astrolabes contain Ibn Bāṣo’s universal plate

for all latitudes. The retes are almost alike in their design and have exactly the same 36 star pointers. However, the gazetteer in this astrolabe appears to have been engraved by a different person, probably at a later point of time (see below under Gazetteer).

Components

Body with crown (d. 208, h. 267, t. 10), shackle and ring, rete (d. 198) for 36 stars, 6 plates (d. 198), alidade (l. 205), pin and wedge. The shackle and ring are crude replacements.

Front

The ring is plain with roundish cross-section, crudely soldered together. The shackle is also plain with a flat oval cross-section. The ring and shackle are clearly late replacements.

The profiles of the *kursī* consist of ogival bases with decorative holes, followed by three successive lobes. The finial is trifoliate. Leaving out a broad border, the rest of the *kursī* is elegantly reticulated. The limb is divided in 1° and numbered in 5s from 5 to 360.

Rete

The rete is thick in the middle and tapers slightly towards the circumference. The rings of the Tropic of Capricorn and ecliptic are held together by the equinoctial bar which is counter-changed at the centre. The spaces between the two rings and that inside the ecliptic ring are filled with a delicate tracery of tendrils terminating in tulip-like flowers. The tulips have two flared petals, one larger than the other; where the two petals branch off is a small hole pierced through the whole thickness. The holes are filled with black substance so that it shows at the back also. In the front the holes have a pleasing decorative function. The back is smooth and neatly polished with the black dots standing out.

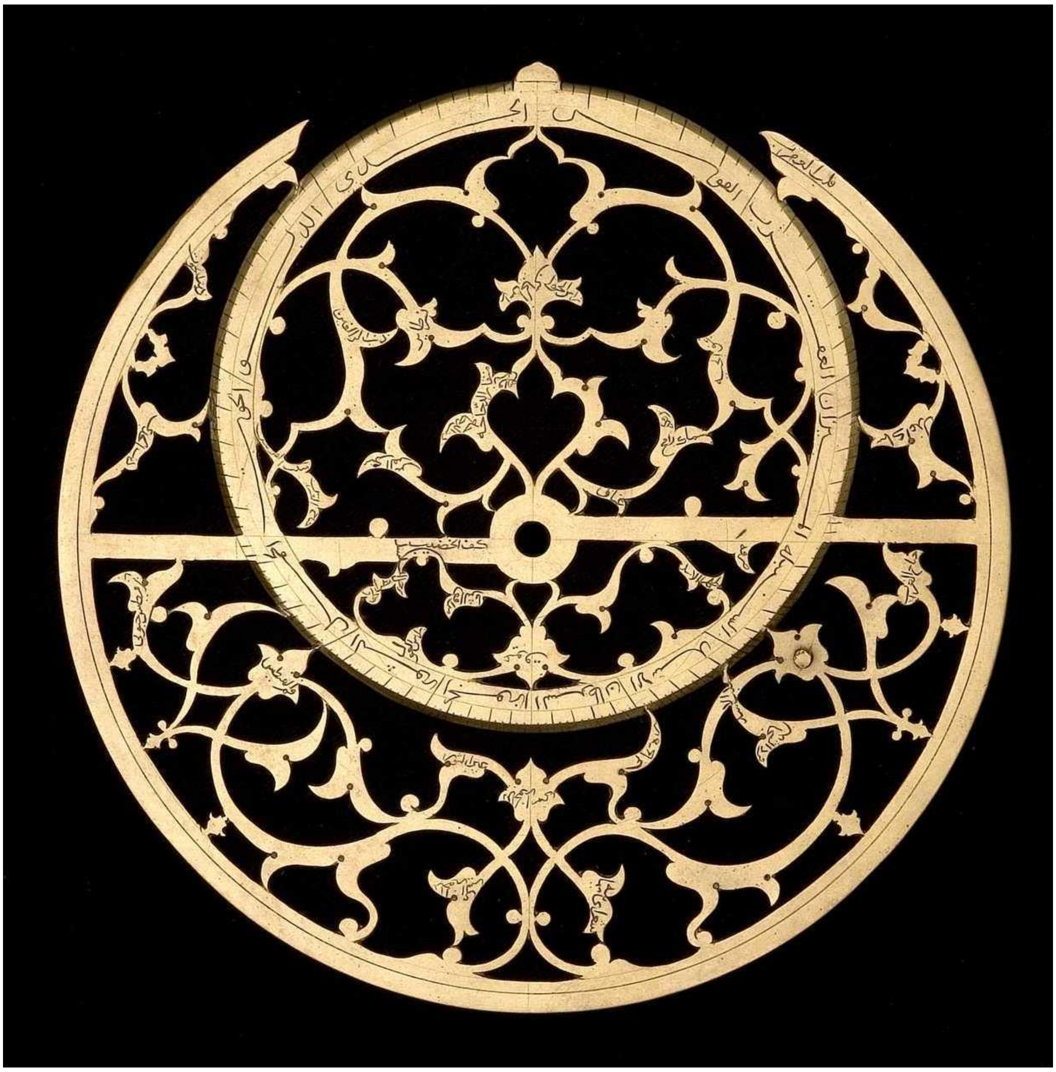

Figure A003.2 – Rete of the Astrolabe (© Museum of the History of Science, Oxford)

There is a small handle just outside the ecliptic ring in the segment of Virgo. A small triangular projection rising from the ecliptic ring at the zero point of Capricorn is the *al-murī* or the Capricorn index.

The ecliptic ring is divided into the 12 zodiac signs and labelled. Each sign is divided into 5 parts but these are not numbered. On the sloping edge of the ring, each of these parts is divided into 3 units, each of 2°.

There are 36 star pointers in the form of tulip petals. These are exactly the same as in the undated astrolabe by Allāhdād (A002).

Table A003-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab Qayṭus Janūbī*	β Ceti

	Star Name	Identification
2	*Batn al-Ḥūt*	β Andromedae
3	*Rijl al-musalsala*	γ Andromedae
4	*Fam al-Qayṭus*	γ Ceti
5	*Rās al-Ghūl*	β Persei
6	*Mirfak al-Thurayyā*	α Persei
7	*ᶜAyn al-Thawr*	α Tauri
8	*ᶜAyyūq*	α Aurigae
9	*Rijl al-Jawjā’ al-Yusrā*	β Orionis
10	*Yad al-Jawjā’ al-Yumnā*	α Orionis
11	*Shiᶜrā Yamānī*	α Canis Majoris
12	*Shiᶜrā Shāmī*	α Canis Minoris
13	*Fard al-Shujāᶜ*	α Hydrae
14	*Qalb al-Asad*	α Leonis
15	*Ẓahr al-Asad*	δ Leonis
16	*Ṣarfa*	β Leonis
17	*Janāḥ al-Ghurāb*	γ Corvi
18	*ᶜAnāq*	ζ Ursae Majoris
19	*Simāk Aᶜzal*	α Virginis
20	*Simāk Rāmiḥ*	α Bootis
21	*Nayyir Fakka*	α Coronae Borealis
22	*ᶜUnuq al-Ḥayyā*	α Serpentis
23	*Qalb al-ᶜAqrab*	α Scorpii
24	*Rās al-Ḥawwā’*	α Ophiuchi
25	*Rās al-Jāthī*	α Herculis

	Star Name	Identification
26	*Nasr Wāqīʿ*	α Lyrae
27	*Minqār al-Dajāja*	β Cygni
28	*Nasr Ṭā'īr*	α Aquilae
29	*Dhanab al-Dulfīn*	ε Delphini
30	*Dhanab al-Dajāja*	α Cygni
31	*Dhanab al-Ḥūt*	γ Gruis
32	*Mankib al-Faras*	β Pegasi
33	*Matn al-Faras*	α Pegasi
34	*Dhanab al-Jadī*	δ Capricorni
35	*Janāḥ al-Faras*	γ Pegasi
36	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are six plates of varying thickness and colouration, serving nine different latitudes.

Table A003-2 Plates

	φ	Longest Day	(Locality)
1a	17;0°	13;2 hrs	
1b	36;10°	blank	
2a	21;40°	13;14	(Mecca)
2b	25;0°	13;25	(Medina)
3a	27;0°	13;44	(Agra)
3b	32;0°	14;8	(Lahore)

	φ	Longest Day	(Locality)
4a	30;0°[191]	13;18	
4b	40;0°	14;54	
5a	45;0°	15;30	
5b	Tablet of horizons		
6a	Tablet of ecliptic coordinates		
6b	Ibn Bāṣo’s universal plate for all latitudes		

Interestingly, the two sides of plate 2 are devoted to Mecca and Medina, the holy cities of Islam. This juxtaposition was never repeated in any other Indian astrolabe. The two sides of plate 3 are devoted to Agra and Lahore, the two Mughal imperial cities. This practice was emulated by his descendants. There are no silver inlays on any plate here. Below the horizon are engraved *al-mashriq* and *al-maghrib* on the eastern and western sides respectively. In the centre are engraved the latitude (*al-arḍ*) and the duration of the longest day in two lines one below the other.

Altitude circles are for every 2°; on some plates the numbers form a semicircular arc, on others the characteristic round M shape. Azimuths are drawn for every 10° below the horizon. The style of their numbering varies from plate to plate. On some the numbers are engraved below and along the oblique horizon and below and along the circle of the Tropic of Cancer (e.g. 1b). On some other plates, there are two sets of numbers, one along the horizon and another at the northern end of azimuths in such a way that the numbers form two sides of an isosceles triangle. Yet on some other plates (e.g. 2b) one set is engraved in an arc above the equatorial circle and another set as in the previous case so that where the apex of the triangle touches the arc, one finds the number 90 in *abjad* arranged four times in pleasing symmetry.

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191 Instead of the zero sign, the engraver by mistake wrote the letter ayn (ع) which would have given the value of 70 in the minutes’ place!

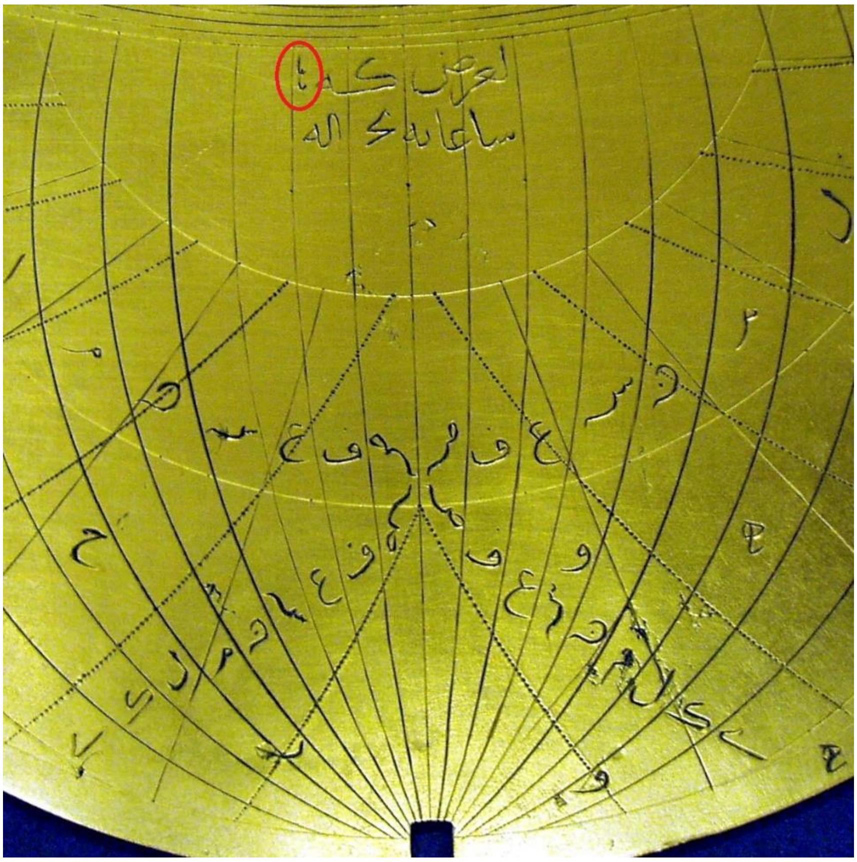

Figure A003.3 – Plate for 25°; note the the arrangement of the numbers of the azimuth circles; also the shape of zero (photo by S. R. Sarma)

On some other plates (3a) there are two sets, one in the form of an arc and another in the form of a truncated triangle.

There are two sets of hour lines on all latitude plates, for seasonal hours and for equal hours since sunset and before sunrise, both reaching up to the meridian, but both sets are numbered from the western horizon in elegant *abjad* symbols.

5b Tablet of horizons

Four sets of half horizons are engraved on the plate in the eastern fashion. Each set is labelled four times along the length of the half horizons. The half horizons for latitudes ranging from 4° to 66° are arranged at intervals of 8° in four batches in the following manner:

4	12	20	…	44	52	60
6	14	22	…	46	54	62
8	16	24	…	48	56	64
10	18	26	…	50	58	66

There are no declination scales, nor a label on the plate.

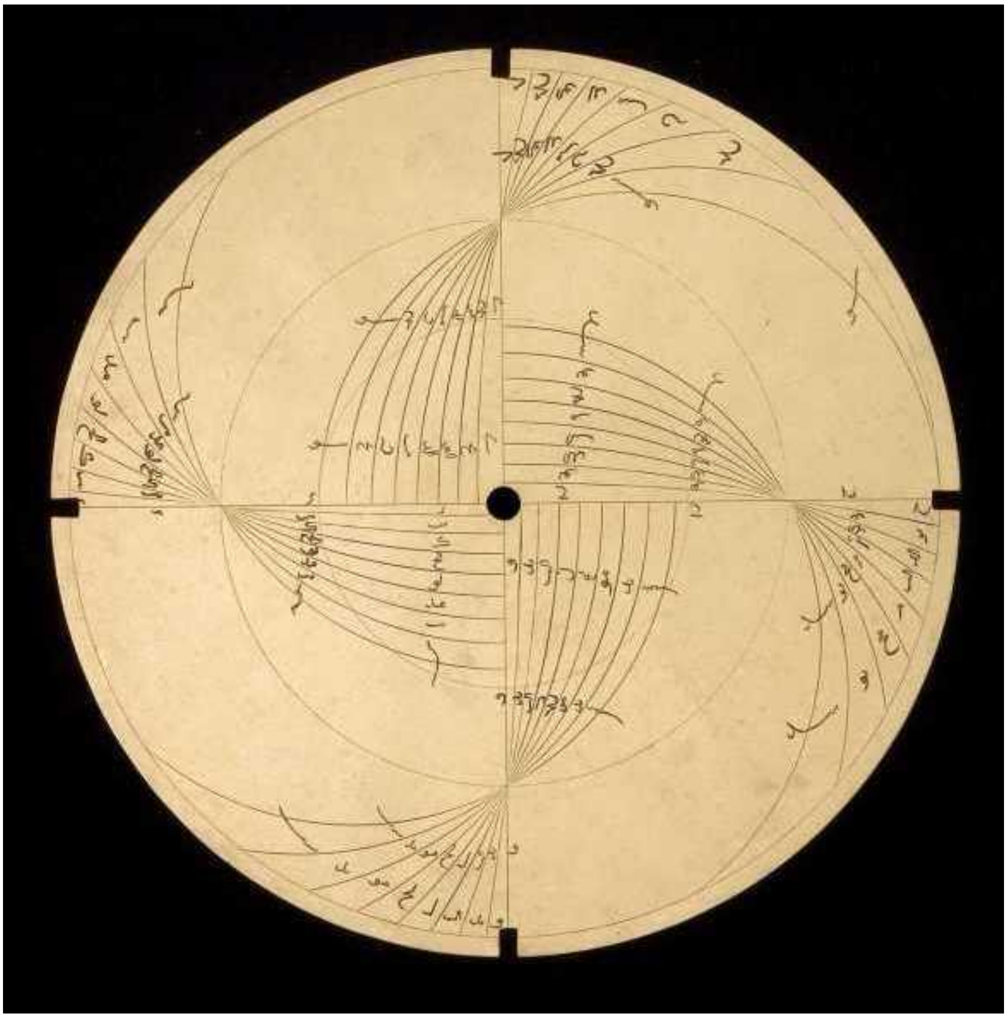

Figure A003.4 – Tablet of horizons (© Museum of the History of Science, Oxford)

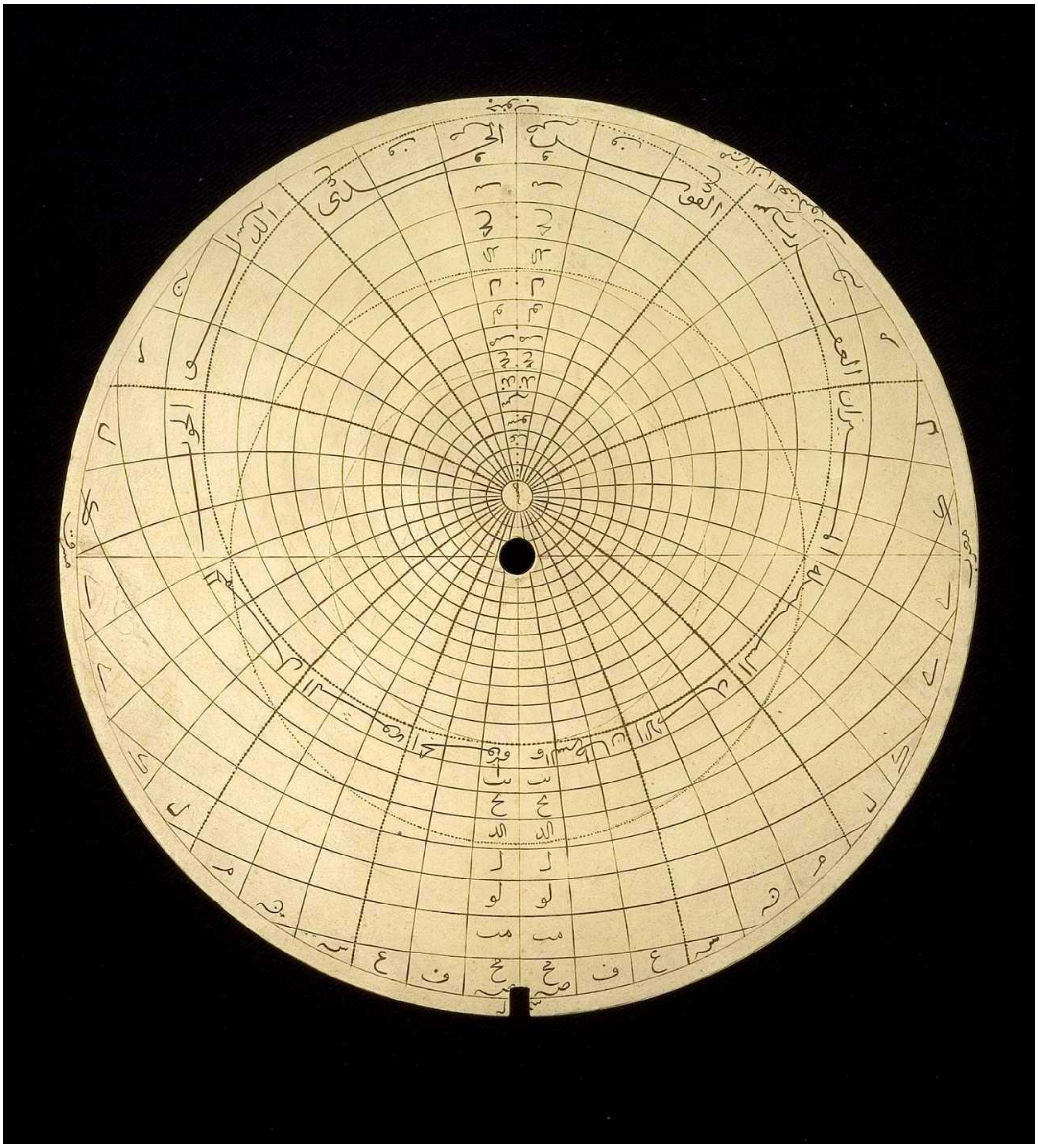

Figure A003.5 – Tablet of ecliptic coordinates (© Museum of the History of Science, Oxford)

6a Tablet of ecliptic coordinates

This plate is thicker and more yellowish than the other plates. On it are drawn first the equator and the two tropics. The equator and the Tropic of Cancer are drawn as dotted lines, the latter is rather faint. The ecliptic is also drawn as a dotted line and marked with the names of the 12 signs of the zodiac, starting at the vernal equinox and proceeding counter-clockwise.

Arcs of celestial longitudes radiating from the centre are drawn for every 10°. Every third of these, which constitutes the boundary of the signs, is dotted. The arcs are numbered along its entire circumference 10—90; 90—10; 10—90; 90—10.

Circles of celestial latitudes are drawn for every 6° as concentric circles around the zenith. These are numbered in two columns from the south point up to the centre from 6 to 90; again from the ecliptic circle up to the north point from 6 to 90.

Outside the Tropic of Capricorn the four cardinal points are marked and labelled *mashriq, maghrib, janūb and shamāl.*

In the south-west corner outside the line of the Tropic of Capricorn is the label *mīẓān al-ᶜankabūt.*

6b Universal plate for all latitudes

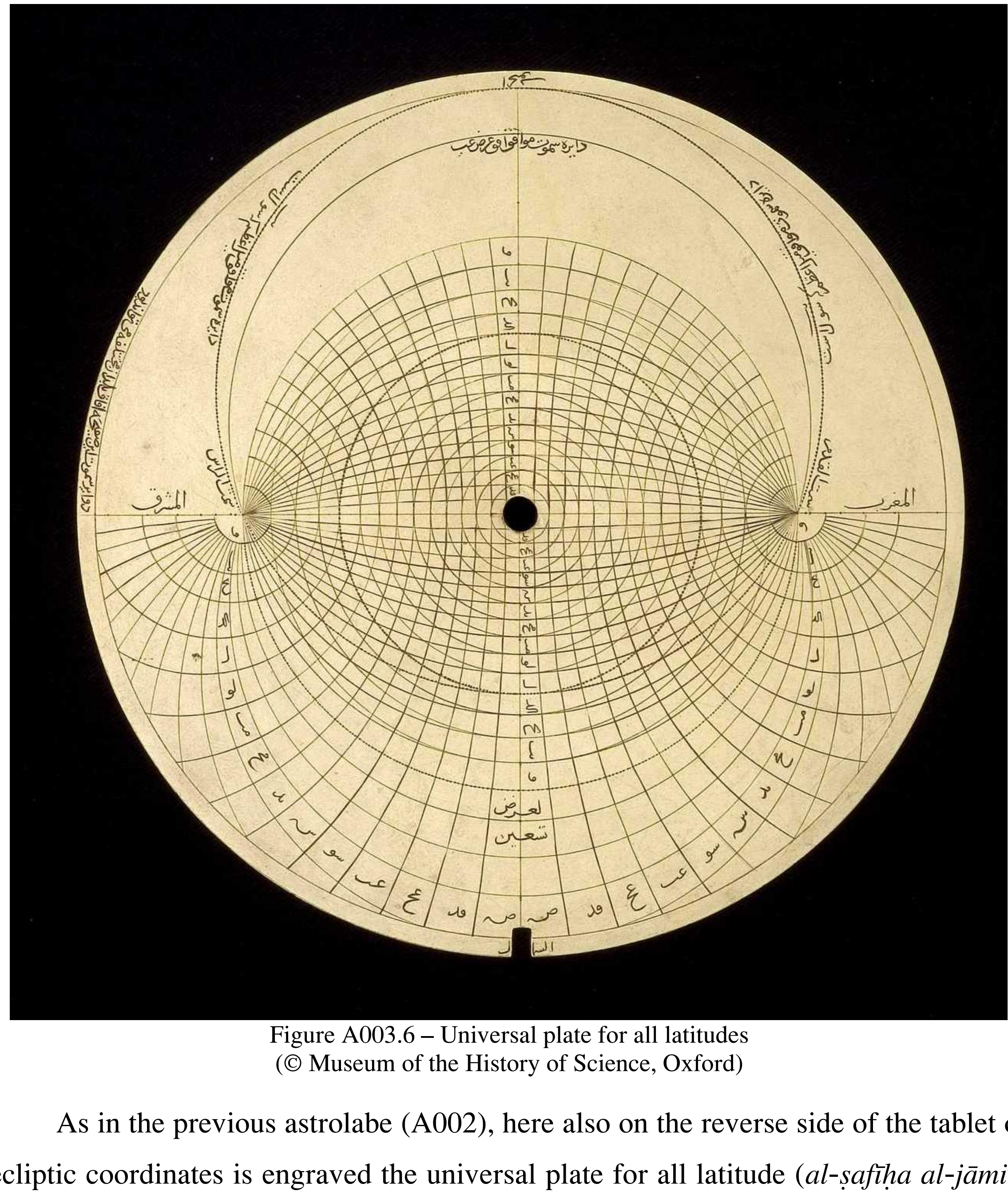

Figure A003.6 – Universal plate for all latitudes
(© Museum of the History of Science, Oxford)

As in the previous astrolabe (A002), here also on the reverse side of the tablet of ecliptic coordinates is engraved the universal plate for all latitude (*al-ṣafīḥa al-jāmiᶜa*

*li-jāmī*ᶜ *al-*ᶜ*urūḍ*) which was designed by Ibn Bāṣo.[192] No lines are inlaid here with silver, but there are 11 labels at different places.

As on the obverse side, here also the cardinal directions are labelled. At the east and west points *al-mashriq* and *al-maghrib* respectively; and at the south and north points outside the peripheral circle *al-janūb* and *al-shamāl.*

As in A002, three families of circles are drawn here. First, the 30 arcs of great circles passing through the east and west points. These are horizons for each 6° of terrestrial latitudes from +90° to -90°. These are not numbered.

Then around the east and west points are drawn 15 arcs each at 6° intervals. These arcs divide horizons into equal parts. The numbers of these arcs start from the east and west points and proceed along lower periphery up to the meridian line.

Third, around the centre are drawn 14 concentric circles at 6° intervals; these constitute the altitude circles for the latitude of 90°. These circles are numbered along the vertical diameter both above and below the centre. Starting at 6 below, the numbering continues up to the centre and then from 90 at the centre it goes up to 6 at the top. The circle of 24° is emphasized by dots. The lower half of the outermost circle, which is the eqator, is dotted. Below this circle is written, across the meridian line, *al-*ᶜ*arḍ tiṣīn* (the latitude of 90 [degrees]).

In A002, three semi-circles are traced between the equator and the outer circle of the plate. These semi-circles are not drawn here. But two circles which pass through the east and west points are extended into the southern half. One of these is drawn with its centre on the meridian at 36° to south of the centre of the plate. Where this circle intersects the meridian in the south is a label which reads *dā'ira samūt muwāfiq ufq* ᶜ*arḍ 72* (circle of azimuths corresponding to the horizon of the latitude 72°).

Another circle is drawn with its centre on the meridian at 42° to south of the centre of the plate; it passes through the east and west points and extends into the southern half of the plate. This circle is completely dotted and carries four labels in the southern half. Where it emerges into the southern half after passing through the east point is written *samt al-rās* (azimuth of the head?). Where the circle emerges after passing through the

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192 On Ibn Bāṣo, see Calvo 2007; on the construction and use of the plate, see Calvo 2000.

west point is written *samt al-qadam* (azimuth of the foot?). A little above these labels, there is an identical label on both sides, which reads *dā'ira samūt muwāfiq mayl a*ᶜ*ẓam karsū lāsat* (circle of azimuths corresponding to the maximum obliquity … ?); above this is written 12 in *abjad* notation.

Finally, outside the circle of the Tropic of Capricorn, just above the east point is a long label *dawā'īr samūtā'īn ṣafīḥat afāq buldān* … (?).

GEOGRAPHICAL GAZETTEER

On the inner side of the mater, a geographical gazetteer is engraved in four concentric circles containing geographical data of 104 localities. Above the outer or first circle, compass directions are engraved at the east (*al-mashriq*), south (*al-janūb*) and west (*al-maghrib*) points. At the north point, the space is occupied by a plug to receive the notches cut in the plates.

In the first circle, two adjacent cells are filled with the name of a single locality so that the degrees and minutes of the latitudes etc. are written in separate cells. Mecca and Medina are mentioned without the honorifics. For each locality are given its name (*asmā' al-buldān*), latitude (*al-*ᶜ*arḍ*), co-latitude (*tamām al-*ᶜ*arḍ*), and longitude (*al-ṭūl*) in this order. This is perhaps the only astrolabe to list co-latitudes (90- φ), which can easily be calculated from the latitudes. Even so at least in five cases (nos. 56, 62, 76, 94, 95) there are errors, for the values of the latitude and co-latitude do not add up to 90! In fact, this gazetteer does not even follow the traditionally accepted parameters for the two holy cities of Islam, namely Mecca (Long. 67 as against 77;10) and Medina (Long 65;20, Lat. 24;20 as against Long. 75;20, Lat. 25;0).

Moreover, three types of symbols for zero are used in this astrolabe. On the plates are seen two different symbols which are, however, quite common.

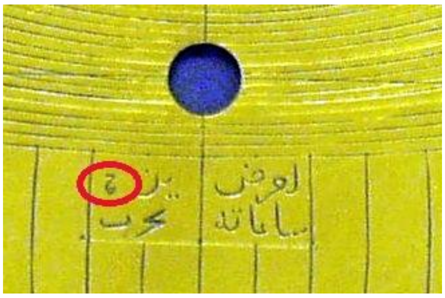

Figure A003.7 – Zero symbol on the plate for 17° (photo by S. R. Sarma)

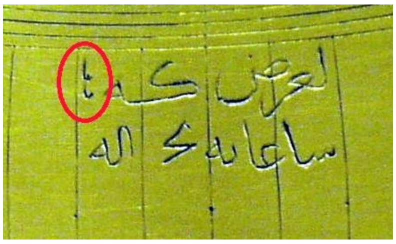

Figure A003.8 – Zero symbol on the plate for 25° (photo by S. R. Sarma)

But in the gazetteer, one encounters an entirely unusual symbol.

Figure A003.9 – Zero symbols in the gazetteer (photo by S. R. Sarm)

The quality of calligraphy in the gazetteer is not very good; the quality of engraving is also poor. Some dots seem to have been punched mechanically. In the inner ring, the *abjad* symbols are scratched rather than engraved. The gazetteer was clearly engraved by a different hand.

The argument occupies the first two cells to the left of the vertical diameter, and the gazetteer is arranged counter-clockwise. In the following table, as in the other tables, we mention the name of the locality, longitude, latitude, and other parameters, in this order for the sake of consistency.

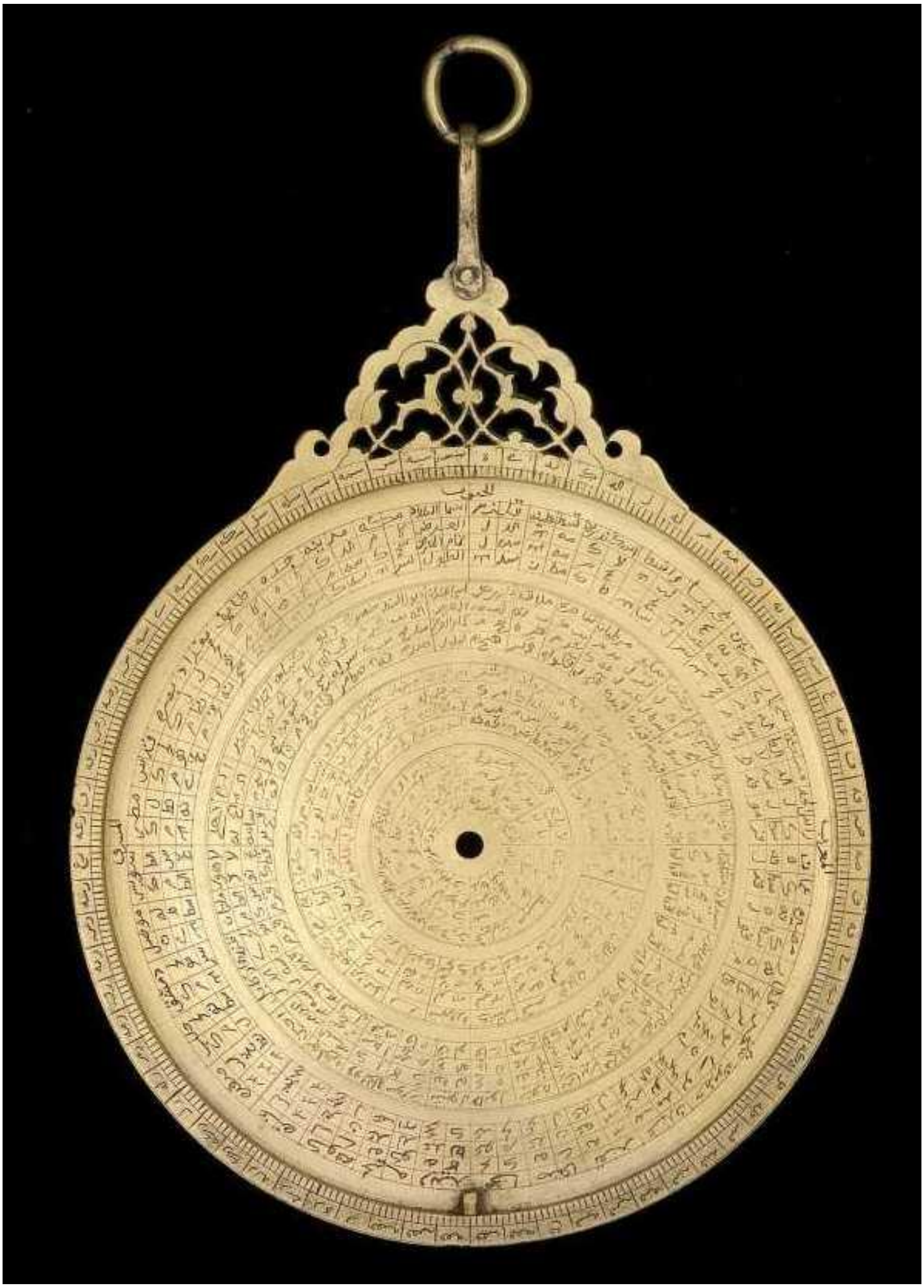

Figure A003.10 – Geographical gazetteer (© Museum of the History of Science, Oxford)

Table A003-3 Geographical Gazetteer

	Place Name	L	φ	Co-latitude
	(*asmā' al-buldān*)	(*al-tūl*)	(*al-ᶜarḍ*)	(*tamām al-ᶜarḍ*)

	Place Name	L	φ	Co-latitude
	First Circle			
1	Makka	67;0	21;40	68;20
2	Madīnah	65;20	24;20	65;40
3	Jadda	66;0	21;5	68;55
4	Tā’īf	65;20	21;20	68;40
5	Baghdād	63;55	33;30	56;30
6	Baṣra	83;40	30;20	59;40
7	Qadis	58;10	33;20	56;40
8	Miṣr	55;0	30;20	56;40
9	Sūs	58;29	29;20	60;40
10	Moṣul	58;29	35;50	54;10
11	Dimashq	67;0	33;20	56;40
12	Ḥalab	69;30	33;20	56;40
13	Ṣafada	59;0	32;0	58;0
14	Ghaza	58;0	32;0	58;0
15	Kūfa	68;30	32;10	57;50
16	Laḥya ?	72;0	15;26	74;14
17	Zabīd	73;20	15;21	74;39
18	Makhā	72;33	13;20	76;40
19	Ṣana^{c}ā’	73;30	15;10	74;50
20	Ta^{c}izz	75;30	15;0	75;0
21	^{c}Adan	73;25	12;44	77;15
22	Hadhramūt	73;35	16;10	73;50
23	Shahar	77;36	16;17	73;43

	Place Name	L	φ	Co-latitude
24	Ẓafār	81;40	18;55	71;5
25	Maṣūrah	86;30	20;55	69;5
26	ᶜAmān	87;30	20;5	69;55
27	Rās al-Jad ?	87;46	20;30	69;30
28	Muskah	84;23	24;29	65;31
29	Suhār	83;40	25;20	64;40
30	Baḥrayn	83;0	25;15	64;45
31	Laḥsā	67;30	18;0	72;0
32	Wasit	61;0	32;0	58;0
33	Iskandariyya	51;20	31;20	58;40
34	Qasṭanṭaniyya	49;50	45;0	45;0
35	Qulzum	64;0	24;30	65;0
	Second Circle			
36	Daywal al-sind	95;0	25;12	64;48
37	Manṣūra	105;0	27;40	62;20
38	Diū ?	99;47	22;25	67;35
39	Kanbāyata	101;0	21;40	68;20
40	Aḥmadābād	108;40	23;15	66;45
41	Ajmīr	111;5	21;7	68;53
42	Akra	115;0	27;0	63;0
43	Dehlī	118;17	28;15	61;45
44	Lāhūr	109;20	31;4!	58.56
45	Multān	107;40	29;40	60;20
46	Qandahār	107;40	33.10	56;50

	Place Name	L	φ	Co-latitude
47	Kābul	104;40	34;30	65;30
48	Ujjayn	112;0	25;0	65;0
49	Nahlawara	112;30	22;0	68;0
50	Dawlatābad	107;0	20;30	69;30
51	Sūrat	101;0	21;20	68;40
52	Shīwar?	101;36	19;35	70;25
53	Dābūl	101;10	18;5	71;55
54	Jawah	102;10	15;56	74;4
55	Bījāpūr	120;0!	20;0	70;0
56	Manhlūr ?	102;35	12;55!	77;45!
57	Koshī	103;36	9;26	80;34
58	Sarandīb	130;0	10;0	80;0
59	Muḥammad Bandar	107;39	12;0	78;0
60	Siyalān	109;39	6;48	83;12
61	Mashalfitār	109;39	16;40	73;20
62	Mānīk Batan	112;9	19;18!	71;32!
63	Bankālā [Dhakā]	122;45	22;50	67;10
64	Nashtarjām	112;0	23;30	66;30
65	Rakhban?	117;4	20;30	69;30
66	Baykū	114;20	17;30	72;30
67	Martabān	123;30	14;40	75;20
68	Tanāṣarī ?	126;35	12;20	77;40
69	Malāqa	127;?	2;55	87;5

	Place Name	L	φ	Co-latitude
70	Shaharnū	118;0	32;0	58;0
	Third Circle			
71	Iṣfahān	77;40	34;50	55;10
72	Shīrāz	78;0	32;20	57;40
73	Sīrāf	79;0	29;50	60;10
74	Nīshābūr	81;45	36;20	53;40
75	Samarqand	89;30	36;50	53;10
76	Halwān	71;45	32;20!	56;40!
77	Najāra	96;19	39;10	50;50
78	Kanja	81;30	41;20	38;40
79	Ardabīl	74;30	38;0	52;0
80	Rayy	76;20	35;0	55;0
81	Suhraward	76;20	37;0	53;0
82	Kāshān	76;0	37;0	53;0
83	Qum	75;0	37;45	52;15
84	Hamadān	61;0	36;20	53;40
85	Ṭāliqān	75;17	36;10	53;50
86	Herāt	87;20	34;30	55;30
87	Balkh	71;0	36;41	53;[19]
88	Mārdayn	74;0	37;15	52;45
89	Tabrīz	87;0	38;0	52;0
90	Harmūz	73;0	28;19	61;41
91	Hāshah?	85;29	26;50	63;10
92	Kermān	94;0	29;20	60;40

	Place Name	L	φ	Co-latitude
93	Kāshghar	105;25	47;20	42;40
	Fourth Circle			
94	Barāwa	72;30	1;40!	83;20!
95	Maghaz Showa?	73;20	2;19!	87;45!
96	Saynū al-Ṭūbal	77;16	6;20	83;40
97	Bandar Kos	79;0	9;30	80;30
98	Hā Fūn	80	10;20	79;40
99	Qaylak	77;20	12;5	77;55
100	Meeṭ	75	11;20	78;40
101	Barbada	73;22	11;0	79;0
102	Zaylaᶜ	77;36	11;30	78;30
103	Qaṣār	67;6	14;20	75;40
104	Maṣūᶜ	64;15	17;0	73;0

BACK

The degree scale on the rim is slightly wider (10 mm) than that at the front (8 mm). In the upper two quadrants, the scale is divided in 1° and 5° and labelled as 5—90; 90—5. The rim is empty in the lower half.

In the upper left is a trigonometric quadrant with 60 horizontal and 60 vertical equidistant parallels.

In the upper right is the solar quadrant with declination arcs drawn for each 30° of solar longitude or one zodiacal sign. The signs are labelled along the vertical and horizontal radii by their serial numbers from 0 to 11.

Under the horizontal diameter is written *al-mashriq* on the east and *al-maghrib* on the west. In the lower half are the shadow squares. On the left for the gnomon of 12 digits; the vertical and horizontal scales are divided in 12 units. In the vertical scale the

numbering begins at the horizontal diameter of the astrolabe, in the horizontal scale it begins at the centre. The label along the vertical scale reads *ẓill aṣābi*^{c} *ma*^{c}*kūs* (reverse shadow in digits), that under the horizontal scale simply *mustawī* (direct [shadow]).

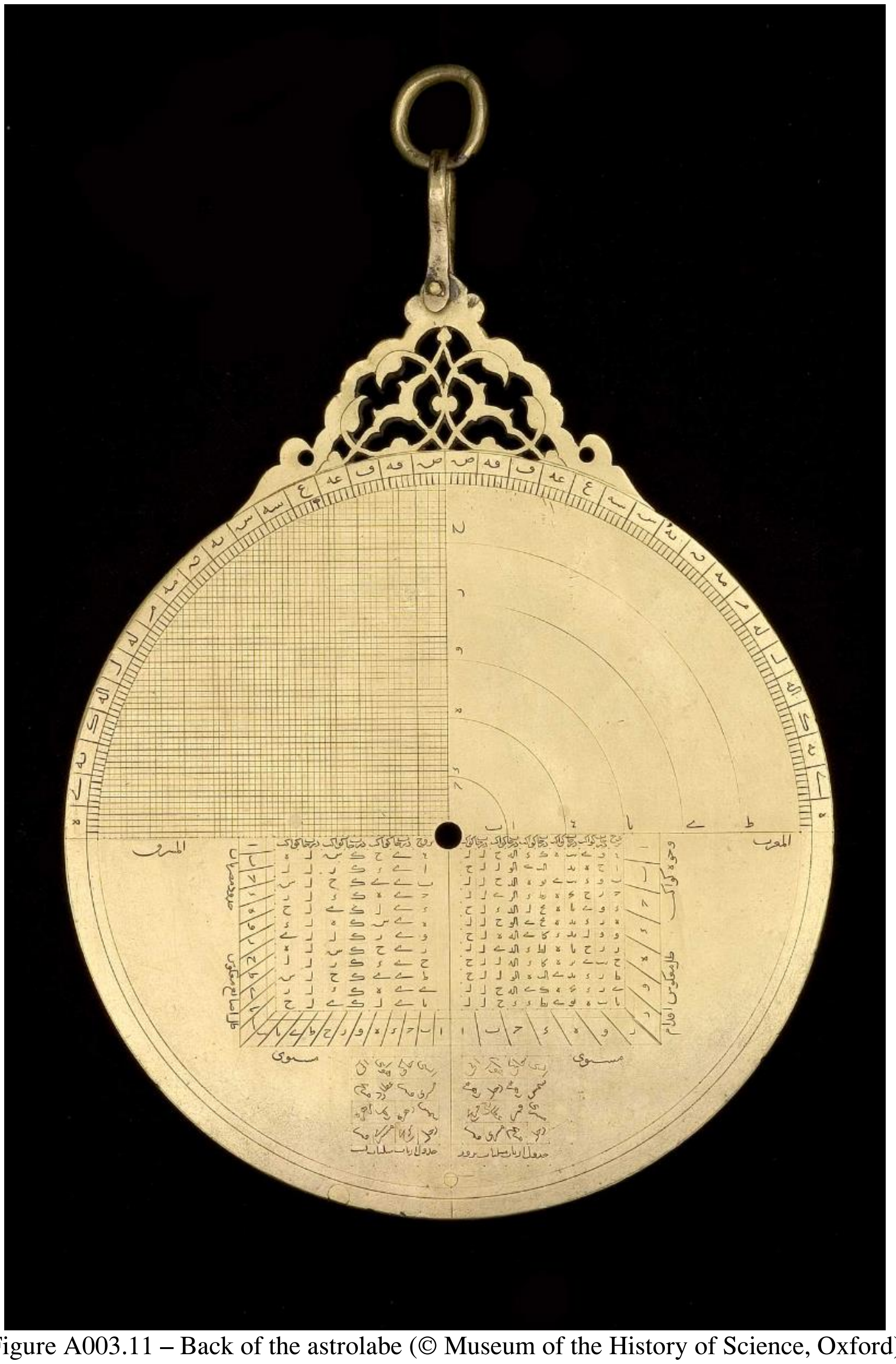

Figure A003.11 – Back of the astrolabe (© Museum of the History of Science, Oxford)

On the right is the square for 7 feet; here the scales are divided in 7 units and numbered in the same manner as on the left. The label along the vertical scale reads *ẓill ma*^{c}*kūs aqdām* (reverse shadow in feet) and that under the horizontal scale simply as *mustawī* (direct [shadow]).

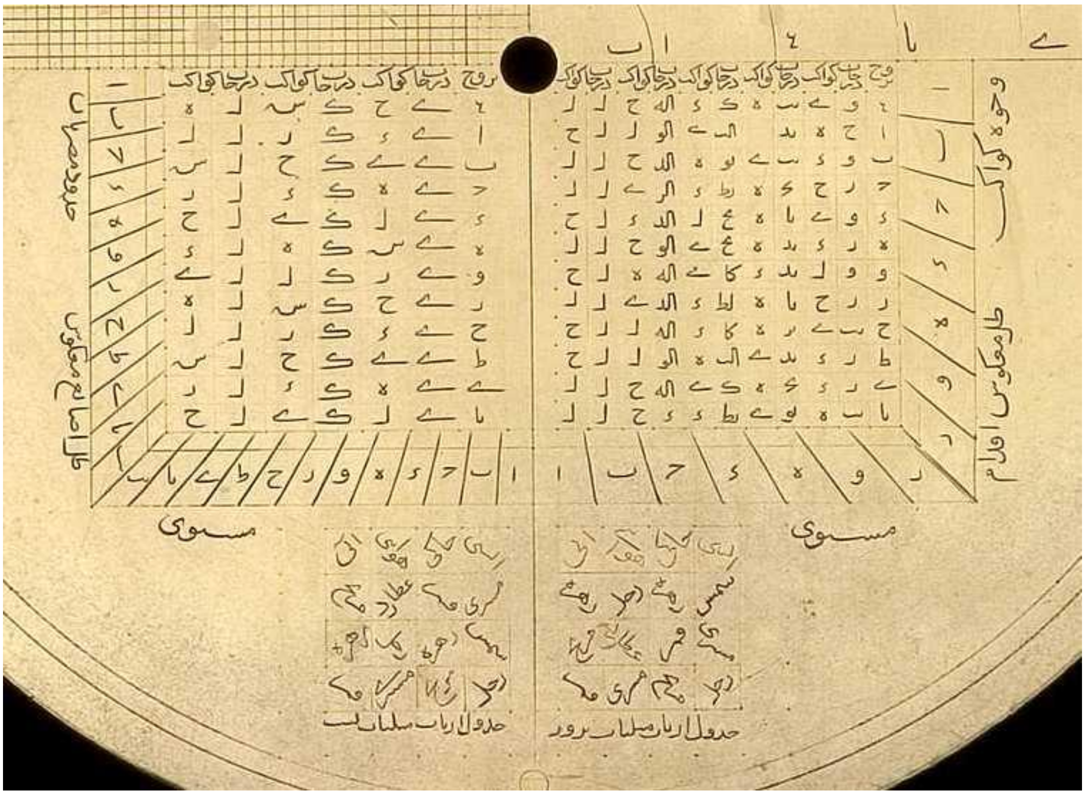

Figure A003.12 – Astrological tables on the back (detail of Figure A003.11)

Table of Decans or Faces of the Signs

Inside the squares are two astrological tables. On the left is a table with 7 columns and 13 rows which displays the regents of the decans.[193] The first column on the right carries the argument, viz., the names of the 12 signs through their serial numbers from 0 to 11. The following columns show alternately the degrees of decans in *abjad* notation and the names of the presiding planets through the last letters of their names. In table below, we give the full names of the signs and planets, instead of the symbols.

Table A003-4 Faces of the Signs

	Degrees *darjāt*	**Planets** *kawākib*	**Degrees** *darjāt*	**Planets** *kawākib*	**Degrees** *darjāt*	**Planets** *kawākib*
0. Aries	10	Mars	20	Sun	30	Venus
1. Taurus	10	Mercury	20	Moon	30	Saturn
2. Gemini	10	Jupiter	20	Mars	30	Sun

193 Cf. Kaye 1918, p. 123.

	Degrees *darjāt*	Planets *kawākib*	Degrees *darjāt*	Planets *kawākib*	Degrees *darjāt*	Planets *kawākib*
3. Cancer	10	Venus	20	Mercury	30	Moon
4. Leo	10	Saturn	20	Jupiter	30	Mars
5. Virgo	10	Sun	20	Venus	30	Mercury
6. Libra	10	Moon	20	Saturn	30	Jupiter
7. Scorpio	10	Mars	20	Sun	30	Venus
8. Sagittarius	10	Mercury	20	Moon	30	Saturn
9. Capricorn	10	Jupiter	20	Mars	30	Sun
10. Aquarius	10	Venus	20	Mercury	30	Moon
11. Pisces	10	Saturn	20	Jupiter	30	Mars

Table of Limits

On the right is another astrological table, displaying the ‘limits’ or ‘terms’ in 11 columns and 13 rows. The first column on the right carries the argument, viz., the names of the 12 signs through their serial numbers. The following columns show alternately the degrees (*darjāt*) of limits in *abjad* notation and the names of the presiding planets (*kawākib*) through the last letters of their names. In the table below, instead of the symbols, we shall give the full names of the signs and planets. Owing to the lack of space in the table, the argument *darjāt* (degrees) is substituted by *x*.

Table A003-5 Limits of the Signs

Signs *burūj*	*x*	Planets *kawākib*	*x*	Planets *kawākib*	*x*	Planets *kawākib*	*x*	Planets *kawākib*	*x*	Planets
0. Aries	6	Jupiter	12	Venus	20	Mercury	25	Mars	30	Saturn
1. Taurus	8	Venus	14	Mercury	22	Jupiter	26	Saturn	30	Mars
2. Gemini	6	Mercury	12	Jupiter	16	Venus	24	Mars	30	Saturn
3. Cancer	7	Mars	13	Venus	19	Mercury	27	Jupiter	30	Saturn

Signs *burūj*	*x*	**Planets** *kawākib*	*x*	**Planets** *kawākib*	*x*	**Planets** *kawākib*	*x*	**Planets** *kawākib*	*x*	**Planets**
4. Leo	6	Jupiter	11	Venus	18	Saturn	24	Mercury	30	Mars
5. Virgo	7	Mercury	14	Venus	18	Jupiter	26	Mars	30	Saturn
6. Libra	6	Saturn	14	Mercury	21	Jupiter	25	Venus	30	Mars
7. Scorpio	7	Mars	11	Venus	19	Mercury	24	Jupiter	30	Saturn
8. Sagittarius	12	Jupiter	17	Venus	21	Mercury	25	Saturn	30	Mars
9. Capricorn	7	Mercury	14	Jupiter	22	Venus	26	Saturn	30	Mars
10. Aquarius	7	Mercury	13	Venus	20	Jupiter	25	Mars	30	Saturn
11. Pisces	12	Venus	16	Jupiter	19	Mercury	28[194]	Mars	30	Saturn

Strangely enough the labels designating these two tables are erroneously interchanged. The label on the left reads *ḥudūd miṣriyān* (limits according to the Egyptians); this labels actually pertains to the table on the right. The label on the right reads *wujūh kawākib* (faces of the signs or decans), but this belongs to the table on the left.[195]

Day Regents and Night Regents of Trigons[196]

Below the shadow squares are engraved two small tables on either side of the south-north diameter, presenting respectively the day regents and night regents of the

194 There is an error here; instead of 28, it repeats the symbol of Mercury from the preceding cell.

195 On these tables, see Kaye 1918, pp. 120-126; Khareghat 1950, pp. 10-20.

196 Cf. Kaye 1918, p. 125; Khareghat 1950, p. 22. The sequence of the regents in each column on the astrolabe varies from that given in these two sources. E.g. both Kaye and Khareghat enumerate the

trigons. In these tables the trigons themselves are not mentioned. These are mentioned here in the last row.

Table A003-6 Triplicities

Day Regents ***Jadwal arbāb Muthallathāt* – (?)**					**Night Regents** ***Jadwal arbāb Muthallathāt* – (?)**			
Fiery	Earthy	Airy	Watery		Fiery	Earthy	Airy	Watery
Jupiter *Mushtarī*	Moon *Qamar*	Mercury *ᶜUṭārad*	Mars *Mirrikh*		Sun *Shams*	Venus *Zuḥrah*	Saturn *Zuḥal*	Venus *Zuḥrah*
Sun *Shams*	Venus *Zuḥrah*	Saturn *Zuḥal*	Venus *Zuḥrah*		Jupiter *Mushtarī*	Moon *Qamar*	Mercury *ᶜUṭārad*	Mars *Mirrikh*
Saturn *Zuḥal*	Mars *Mirrikh*	Jupiter *Mushtarī*	Moon *Qamar*		Saturn *Zuḥal*	Mars *Mirrikh*	Jupiter *Mushtarī*	Moon *Qamar*
Aries Leo Sagittarius	Taurus Virgo Capricorn	Gemini Libra Aquarius	Cancer Scorpio Pisces		Aries Leo Sagittarius	Taurus Virgo Capricorn	Gemini Libra Aquarius	Cancer Scorpio Pisces

Alidade, pin and wedge

The alidade is a straight bar alidade with ornate ends and an ornate centre piece. To the ends are attached plain sighting plstes with a single hole in each. On the edge and the surface of the left half are engraved arcs which match with the declination arcs in the upper right quadrant. On the edge of the right half are divisions which correspond to 5 units in the trigonometric quadrant. These divisions are numbered in 5s. There is a broad-headed pin with a slot at the other end into which passes a wedge with the traditional horse head. The wedge may be a replacement.

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fiery day regents in this order: Sun, Jupiter, Saturn, whereas the astrolabe has the sequence Jupiter, Sun, Saturn. The same variation occurs in all columns.

A004⊙ ASTROLABE ATTRIBUTABLE TO ALLĀHDĀD AND ᶜĪSĀ[197]

Not dated, late 16th century, Lahore

Diameter 160 mm

London, National Maritime Museum, Greenwich (# AST0560)

Figure A004.1 – Front of the astrolabe (photo by S. R. Sarma)

[197] The description is based on a brief personal examination in 1993, but mainly on Charette 2005a.

This astrolabe is neither signed and nor dated, yet there are some points of resemblance between this and the astrolabe made by Allāhdād in 1567: solid *kursī,* the unusual design of the rete, the incomplete gazetteer, and the calligraphy of the *abjad* numbers on the limb. As in the undated astrolabe by Allāhdād (A002), there is a tablet of horizons in western style here. Therefore, this astrolabe can be attributed to Allāhdād; it will be argued further that Allāhdād's son ᶜĪsā may have engraved the back and some plate faces in this astrolabe.

Components

Body with crown (d. 160, h. 202, t. 8), shackle and ring, rete (d. 140) for 13 stars, 5 plates, alidade. Pin and wedge are modern replacements.

Front

The ring is very large, but the shackle is rather small. The crown is high and solid, with almost flat lobes in the profiles and a trifoliate finial. The surface of the crown is plain, on which there is an inscription in a later hand: *bi-niᶜmat Allāh,* 'by God's munificence'.

The limb is graduated in 1° and 5° and labelled in 5s from 5° to 360°.

Rete

The rete resembles to a great extent the rete in Allāhdād's astrolabe of 1567. In both the equatorial ring occurs in two disjointed segments, one inside the ecliptic ring and the other in the lower part. In the Hyderabad astrolabe, both the segments are of equal width; here the lower segment is much narrower. In both, the rings are held together by the equinoctial bar which is counter-changed at the centre. In the Hyderabad astrolabe, the solstitial bar runs from the south point to the centre; here it is fully shown, but without any counter change. In both the astrolabes, the star pointers are shaped like tiger's claws.

In the present rete, the ecliptic ring is divided into the 12 signs of the zodiac and labelled; each sign is divided into groups of 6° and numbered from 6 to 30 separately. The edge of the ecliptic circle is divided into 1°. There is a knob at the base of the star pointer α Canis Majoris to rotate the rete. A small triangular projection at the top of the ecliptic circle constitutes the Capricorn index.

There are 13 pointers on which the star names are engraved in starkly abridged form, and about six without labels. The named stars are as follows:

Table A004-1 Stars on the Rete

	Star Name	Identification
1	*Rijl Yusrā*	β Orionis
2	*Yad Yumnā*	α Orionis
3	*Yamānī*	α Canis Majoris
4	*Shāmī*	α Canis Minoris
5	*Fard*	α Hydrae
6	*A*^{c}*jal*	α Virginis
7	*Rāmiḥ*	α Bootis
8	*Fakka*	α Coronae Borealis
9	*Jāthī*	α Herculis
10	*Wāqī*^{c}	α Lyrrae
11	*Ṭā'īr*	α Aquilae
12	*Dhanab* ?	ε Delphini
13	*Kh*(*al-Khaḍīb?*)	β Cassiopeiae

PLATES

There are 5 plates. On these only the latitude is mentioned, but not the duration of the longest day, although the arguments ^{c}*arḍ* and *sā*^{c}*āt* are engraved.

Table A004-2 Plates

	φ	(locality)
1a	21;40°	(Mecca)
1b	34;35°	(Bamyān)
2a	26°	

	φ	(locality)
2b	33°	
3a	35°	
3b	39;37°	(Samarqand)
4a	38°	
4b	Ecliptic coordinates	
5a	54° + 30°	double projection
5b	Tablet of horizons (western style)	

On the latitude plates, altitude circles are drawn for every 3° and each fifth circle is dotted. Azimuth arcs are drawn for every 10° below the horizon. Plain lines for seasonal hours and dotted lines for equal hours since sunset and before sunrise are drawn.

According to Charette, plates 2b and 4a-b were engraved by a person different from the main engraver.

GEOGRAPHICAL GAZETTEER

On the inner surface of the mater is engraved a geographical gazetteer in two annular rings. According to the argument, the following data are planned to be provided: names of the localities (*al-bilād*), their longitudes (*al-ṭūl*), latitudes (*al-ᶜard*), *inḥirāf* (*al-inḥirāf*) and the duration of the longest day (*al-sāᶜāt*), but the cells corresponding to the last two items are left blank as in Allāhdād's astrolabe at Hyderabad (A001). The gazetteer is reproduced in the following table.[198]

198 The table is from Charette 2005a; he does not reproduce place names as they are engraved, but only the modern equivalents.

Table A004-3 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
1	Mecca	77;10	21;40
2	Medina	75;20	25;0
3	Jerusalem	66;30	31;50
4	Alexandria	61;54	30;58
5	Cairo	63;20	30;20
6	Damascus	70;0	33;15
7	Aleppo	72;10	35;50
8	Constantinople	59;50	45;0
9	Maragha	82;0	37;20
10	Tabriz	82;30	38;0
11	Ardabil	83;0	38;0
12	Shamakha	84;30	40;50
13	Kufa	79;30	31;30
14	Baghdad	80;0	33;25
15	Basra	84;0	30;0
16	Shiraz	88;0	29;36
17	Hamadan	83;0	35;10
18	Sawa	85;0	35;0
19	Qazwin	85;0	36;0
20	Isfahan	86;40	37;25
21	Kashan	86;0	34;0
22	Qum	85;40	34;15
23	Rayy	86;20	35;0

	Place Name	L	φ
24	Astarabad	89;35	36;50
25	Simnan	88;0	36;0
26	Damghan	88;55	36;20
27	Bistam	89;30	36;10
28	Sabzwar	91;30	36;5
29	Nishapur	92;30	36;21
30	Tus	92;30	37;0
31	Turshiz	92;0	35;0
32	Tabas-i Gilaki	92;0	33;0
33	Tun	92;30	34;30
34	Qayin	93;20	33;40
35	Heart	94;20	34;30
36	Badghis	94;30	35;20
37	Sarakhs	94;30	37;0
38	Marw	97;40	37;40
39	Faryab	99;0	37;45
40	Balkh	101;0	36;41
41	Bamiyan	102;0	34;35
42	Qabadhiyan	102;0	37;45
43	Talaqan	102;50	37;25
44	Andarab	103;15	34;0
45	Badakhshan	104;25	34;10
46	Bukhara	97;30	39;50
47	Samarqand	99;16	39;37

	Place Name	L	φ
48	Kish	99;30	39;30
49	Khojand	105;35	41;55
50	Kashghar	107;30	44;0
51	Khutan	107;0	42;0
52	Ghazna	104;20	33;35
53	Banjhir	104;40	35;0
54	Ribat-i Amir	105;0	34;0
55	Multan	107;35	29;40
56	Qandahar	106;40	33;0
57	Tibet	110;0	47;0
58	Kashmir	105;0	35;0
59	Delhi	113;35	28;39

Figure A004.2 – Back of the astrolabe (Photo by the Author)

BACK

In the upper half, the altitude scales on the rim are divided in 1° and in 5° and numbered in 5s as 5—90; 90—5.

In the upper left is a trigonometric quadrant with 60 equidistant horizontal and vertical parallels, with every fifth line highlighted with dots.

In the upper right quadrant, there are once again 30 equidistant horizontal parallels. There are also 5 declination arcs; the six zones created by these arcs represent six pairs of the zodiacal signs. The signs are labelled along the vertical and horizontal radii by their serial numbers from 0 to 11.

Upon these declination arcs is superimposed a sigmoid curve of the meridian altitude of the sun for the latitude of 32°, i.e., the latitude of Lahore; it carries the label *khaṭṭ niṣf al-nahār ᶜarḍ l-b* (‘line of the meridian altitude, [for] latitude 32°’).

The rim of the lower half carries the cotangent scales in feet and digits. Inside the rim in the lower left quadrant are engraved the Sanskrit names of the lunar mansions in two quarter circles and the Sanskrit names of the zodiac signs in two more quarter circles. These Sanskrit names are written in Arabic/Persian transliteration. Above these quarter circles is the label *manāzil bi-zabān-i hind* (the lunar mansions in the language of India).

In the right quadrant, the Arabic names of the lunar mansions are engraved in two quarter circles. Inside these quarter circles is a third quarter circle on which there is a scale of 90° with subdivisions for every 30°, 5° and 1°, along which the Arabic names of the zodiacal signs and their serial numbers from 0-11 are engraved.

The Sanskrit names of the lunar mansions as engraved on the astrolabe and the correct forms are reproduced below, both in Roman transliteration.

Table A004-4 Sanskrit Names of the Lunar Mansions

	Astrolabe	Sanskrit
1	*ashnī*	*aśvinī*
2	*bahranī*	*bharaṇī*
3	*kartikā*	*kṛttikā*
4	*rohnī*	*rohiṇī*
5	*margsar*	*mṛgaśirā*
6	*āddrā*	*ārdrā*
7	*punarbas*	*punarvasu*
8	*pugah*	*puṣya*
9	*ashlekhā*	*aśleṣā*
10	*maghā*	*maghā*
11	*purbā bahalkanī*	*pūrvā phālgunī*

	Astrolabe	Sanskrit
12	*utrā bahalkanī*	*uttarā phālgunī*
13	*hasat*	*hasta*
14	*jitrā*	*citrā*
15	*swātī*	*svātī*
16	*visākhā*	*viśākhā*
17	*anrādhā*	*anurādhā*
18	*jyeshthā*	*jyeṣṭhā*
19	*mūlā*	*mūla*
20	*pūrbākhārā*	*pūrvāṣāḍhā*
21	*utrākhārā*	*uttarāṣāḍhā*
22	*sarwan*	*śravaṇa*
23	*abhaj*	*abhijit*
24	*dhanishtā*	*dhaniṣṭhā*
25	*satbhikah*	*śatabhiṣā*
26	*pūrbā bahadbadā*	*pūrvā bhādrapadā*
27	*utrā bahadbadā*	*uttarā bhādrapadā*
28	*rewthī*	*Revatī*

The Sanskrit names of the zodiac signs as engraved on the astrolabe and the correct forms are reproduced below, both in Roman transliteration.

Table A004-5 Sanskrit Names of the Zodiac Signs

	Astrolabe	Sanskrit
1	*mekah*	*meṣa*
2	*barkah*	*vṛṣa*

	Astrolabe	Sanskrit
3	*mithun*	*mithuna*
4	*karkah*	*karka*
5	*simka*	*siṃha*
6	*kanyān*	*kanyā*
7	*tul*	*tulā*
8	*barcihka*	*vṛścika*
9	*dhan*	*dhanuḥ*
10	*makar*	*makara*
11	*kumbh*	*kumbha*
12	*mīn*	*Mina*

Charette considers the Sanskrit names in Arabic/Persian transliteration 'a unique epigraphical source' and refers to similar lists in al-Bīrūnī's treatise on India and in the *Āᶜīn-i Akbarī*[199] and adds that 'it is interesting to note an almost exact correspondence between the spelling on our astrolabe and in the *Āᶜīn-i Akbarī.*'

Between these quarter circles and the east-west diameter of the astrolabe are engraved the two shadow squares. The shadow square on the left is smaller than the shadow square on the right. This is most unusual. Charette explains that the difference in size arose because these squares were drawn after the quarter circles were drawn containing the names of the zodiac signs and lunar mansions.

The shadow square on the left is divided into 7 and that on the right into 12. Inside the corner on the left is the label *ẓill sullam aqdām* (shadow scale in feet). Along the vertical scale is the label *ẓill aqdām maᶜkūs* (umbra versa in feet) and along the horizontal scale *ẓill aqdām mustawī* (umbra recta in feet).

199 Zodiacal signs: Abū al-Faḍl 3, pp. 14-15; Bīrūnī 1910, i. 220.
Lunar Mansions: Abū al-Faḍl 3, pp. 24-25; Bīrūnī 1910, i. 218.

Inside the corner on the right is the label *ẓill sullam aṣābiᶜ* (shadow scale in digits). Along the vertical scale *ẓill aṣābiᶜ maᶜkūs* (umbra versa in digits) and along the horizontal scale *ẓill aṣābiᶜ mustawī* (umbra recta in digits).

ALIDADE, PIN AND WEDGE

The alidade is a straight bar alidade with pointed ends and a plain centre-piece. The edge of one half of the alidade is marked with 60 divisions to match with the divisions on the trigonometric quadrant on the back. It may be a replacement. The pin and the wedge (a bent metal piece) are clearly recent replacements.

Charette notes that the rete and crown of this astrolabe are similar to those of the astrolabe at Hyderabad, that the calligraphy of the *abjad* numerals on the limb is 'exactly identical' in both the astrolabes and that the gazetteers of both the astrolabes are partially completed. It may also be added that these are only two astrolabes produced in India which contain a western type tablet of horizons. Therefore, it is quite possible that the present astrolabe also was made by Allāhdād.

Charette notes that while the main engraver engraved the limb and the gazetteer, the back displays the hand of another engraver. Likewise, while the plate faces 1, 2a, 3 and 5 were engraved by the main engraver, the other engraver engraved the plate faces 2b and 4ab. So these two persons must be contemporary. In particular, the two sides of plate 2 must have been engraved at the same time and those who did the engravings must be contemporary. If we assume that Allāhdād fabricated the astrolabe and engraved the limb, the gazetteer and the places faces 1, 2a, 3 and 5, the other person who engraved the rest must have been his son ᶜĪsā. This assumption gains strength when we consider that the sigmoid graph of the sun's meridian altitude for the latitude 32° of Lahore which appears on the back of the present astrolabe can be seen also in ᶜĪsā's two astrolabes of 1601 and 1604.[200] In sum, this astrolabe can be considered a joint work by Allāhdād and his son ᶜĪsā towards the end of the sixteenth century.

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200 The label on the astrolabes of 1601 and 1604 mentions the latitude 31;50°. The third extant astrolabe by ᶜĪsā, which is undated, does not have this graph. But from this time on it became another hallmark of the Lahore astrolabes. In the astrolabes by Qā'im Muḥammad, Muḥammad Muqīm and Ḍiyā' al-Dīn Muḥammad, it was extended to the Mughal imperial cities of Agra, Lahore and Delhi.

Provenance

The astrolabe was presented to the museum by Sir James Caird in May 1936.

Bibliography

Charette 2005a.

ᶜĪSĀ

Allāhdād's son ᶜĪsa (*fl.* 1601-1604)[201] is known through three astrolabes; a fourth can be attributed to him on stylistic grounds. He may also have engraved parts of an unsigned astrolabe which is attributable to his father (A004). Though of varying sizes, the four astrolabes listed above present a uniform appearance with a solid and multi-lobed *kursī*. More important, in these astrolabes ᶜĪsā introduces for the first time several features which were emulated by his descendants and which become the characteristic features of the Lahore astrolabes.

(i) The sigmoid graph on the back for the meridian altitude of the sun throughout the year. ᶜĪsā draws it for the latitude of Lahore which is the seat of his family. It occurs in A005 (*khaṭṭ zawal*), A006 (*khaṭṭ nisf al-nahār*) and also in A004 (*khaṭṭ niṣf al-nahār*). His son Muḥammad Muqīm usually draws two curves for 29° and 32° which are the latitudes of the two Mughal imperial cities Agra and Lahore, while the nephew Ḍiyā' al-Dīn Muḥammad adds a third graph for 29°, the latitude of Delhi.

(ii) ᶜĪsā engraves the projections for 27° and 32° on the two faces of the same plate.

(iii) Likewise he employs the two sides of the same plate for the tablet of ecliptic coordinates and for the tablet of horizons. In the tablet of horizons, he introduces the scales of declinations along the two diameters.

(iv) He introduces a combined projection for the latitudes 90°and 0° on one of the plates and a similar composite projection of the latitudes 72° and 18° on another plate.

(v) His gazetteers provide only the longitudes and latitudes and ignores the other parameters.

(vi) He reduces the astrological data on the back to the minimum and shows just the correspondences between the twelve signs of the zodiac and the twenty-eight lunar mansions in two concentric semicircles.

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[201] He is usually referred to as Mullā (learned man) by his descendants, but occasionally also as Hāfiẓ, i.e., one who has memorized the entire *Qurᶜān* (e.g. A064).

Thus cĪsā lays the real foundation for what are typically the Lahore astrolabes. The kursī is not yet standardized in his oeuvre, nor the design of the rete. Just as Allāhdād was experimenting with two styles of rete, cĪsā too appears to be trying different styles. The unusual style of rete seen in A006 and in A008 was one such experiment which was not continued later on. The same is the case with the decorative arches in the degree scales and in the gazetteer in A008. This too was not continued in the subsequent astrolabes.

A005⊙ ASTROLABE BY ᶜĪSĀ, AH 1009 (AD 1601)[202]

Diameter 170 mm

Chicago, Adler Planetarium & Astronomy Museum (# N-69)

CCA 3823; Répertore 1

Figure A005.1 – Front of the astrolabe (accession no. N-69)
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

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[202] Entry based on Pingree 2009, no. 13, pp. 52-57.

Components

Body with crown (d. 170, h. 213, t. 11), shackle, ring, rete for 46 stars, 5 plates (3 original and two replacements), un-inscribed alidade (one sight is missing). Modern bolt and nut.

Front

High solid *kursī* with a plain surface; profiles consist of an ogee at the base, followed by two lobes and a trifoliate finial. The trifoliate pattern is repeated in the shackle; seen from the side, it has a trifoliate shape, and the bases through which the pin passes are also given the trifoliate shape.

The scale on the limb is graduated for 1°, 5° and numbered in 5s clockwise from 5 to 360.

Rete

The rings of the Tropic of Capricorn and ecliptic are held together by the equinoctial bar which is counter-changed at the centre. The space between the two rings and that inside the ecliptic is filled by a floral tracery from which emerge star pointers, some shaped like leaves and some others like tiger's claws. The ecliptic ring is divided into the signs of the zodiac and labelled accordingly. Each sign is divided into units of 6° and numbered 6, 12, 18, 24, 30. Each of these units is further subdivided into parts of 2°.

There are 46 named star pointers. Pingree remarks; 'The names of stars are very badly preserved; some I have been unable to read or to identify.' Pingree's star list is rearranged below by the increasing right ascension, but the identifications are as proposed by Pingree.

Table A005-1 Stars on the Rete

	Star Name	Identification
01	*Baṭn al-Ḥūt*	β Andromedae
02	*Rās al-Ghūl*	β Persei
03	*Tālī Masāf al-Nahr*	θ Eridani
04	ᶜ*Ayn al-Thawr*	α Tauri

	Star Name	Identification
05	*ᶜAyyūq*	α Aurigae
06	*Rijl al-Yusrā*	β Orionis
07	*[Yad] al-Jawjā' Yusrā*	γ Orionis
08	*Yad al-Jawjā' Yumnā*	α Orionis
09	*Rijl al-Jawjā' Yumnā*	κ Orionis
10	*Shiᶜrā Yamānī*	α Canis Majoris
11	---*al Furūdayn*	ζ Canis Majoris
12	*Shiᶜrā Shāmī*	α Canis Minoris
13	*Ṭaraf al-Sufīna*	ρ Puppis
14	*Fard al-Shujāᶜ*	α Hydrae
15	*Minkhar Shujāᶜ*	σ Hydrae
16	*Qalb al-Asad*	α Leonis
17	*Ẓahr al-Dubb*	α Ursae Majoris
18	*Qāᶜidat al-Bāṭiya*	α Crateris
19	*Ẓahr al-Asad*	δ Leonis
20	*Zubānā* (?) *al-Asad*	ε (?) Leonis
21	*Janāḥ al-Ghurāb*	γ Corvi
22	*Simāk Aᶜzal*	α Virginis
23	*Al-Mutaqaddim*	ε Virginis
24	*Simāk Rāmiḥ*	α Bootis
25	*Kiffa Janūbī*	α Librae
26	*Kiffa Shamālī*	β Librae
27	*Nayyir al-Fakka*	α Coronae Borealis
28	*Yad al-Ḥawwā'*	δ Ophiuchi

	Star Name	Identification
29	*Qalb al-ᶜAqrab*	α Scorpii
30	*Rās al-Ḥawwā'*	α Ophiuchi
31	*Rukbat al-Ḥawwā'*	ζ Ophiuchi
32	*ᶜAyn al-Tinnīn*	α Draconis
33	*Al-Nasr al-Wāqiᶜ*	α Lyrae
34	*ᶜIṣābat al-Rāmī*	ρ Sagittarii
35	*Minqār al-Dajāja*	β Cygni
36	*Nasr Ṭā'ir*	α Aquilae
37	*Dhanb al-Dulfīn*	ε Delphini
38	*Fam al-Faras*	ε Pegasi
39	*Dhanab al-Jady*	δ Capricorni
40	*Sāq Sākib al-Mā'*	δ Aquarii
41	*Mankib al-Faras*	β Pegasi
42	*Janāḥ al-Faras*	γ Pegasi
43	*Surrat al-Faras*	δ Pegasi
44	*Kaff al-Khaḍīb*	β Cassiopeiae
45	*Muqaddam*	?
46	*…al-janūbiyya*	δ Aquarii ?

PLATES

There are five plates with notches at the north point to fit into the corresponding tab in the mater. Pingree says that two of these plates are 'extraneous' and 'uninscribed'. The three genuine plates serve the following latitudes.

Table A005-2 Plates

	φ	Longest Day
1a	22°	13;22 hours
1b	25°	13;25 hours
2a	27°	13;46 hours
2b	32°	14;8 hours
3a	Tablet of ecliptic coordinates	
3b	Tablet of horizons	

On plates 1 and 2, altitude circles are drawn for every 3° and numbered on both sides of the meridian. The catalogue says that there are 'no azimuths', but azimuth curves can clearly be seen in the photos on p. 57, drawn below the horizon for every 10° and numbered in different styles. There are lines for seasonal hours and equal hours drawn from the western and eastern horizons up to the meridian.

The tablet of ecliptic coordinates carries the label *ṣafīhat mīzān al-ᶜankabūt.* On the tablet of horizons, there are four sets of half-horizons for latitudes ranging from 9° to 81° at intervals of 3°. These are numbered at both ends. Along the radial edges there are declination scales, numbered 6, 12, 18, 24. There is no label mentioning the name of this tablet.

It may be noted that plate 2 is devoted to 27° and 32° which are roughly the latitudes of the two Mughal imperial cities Agra and Lahore. Since this time onwards, this plate and plate 3 (with the tablet of ecliptic coordinates on one side and the tablet of horizons on the other) became an essential feature of the Lahore astrolabes. Moreover, this is the first astrolabe where declination scales are drawn on the tablet of horizons.

Figure A005.2 – Geographical Gazetteer (accession no. N-69)
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

GEOGRAPHICAL GAZETTEER

A geographical gazetteer is engraved in two circles on the inner surface of the mater, providing the names (*asmā' al-buldān*), longitudes (*al-ṭūl*) and latitudes (*al-ᶜarḍ*) of 80 localities, which are 'arranged more or less by region.' Unlike his father, ᶜĪsā does

not attempt to provide other parameters like the *inḥirāf.* The entries are read counter-clockwise from right to left. The symbol for zero is much smaller than the other *abjad* letters and is placed higher than the rest.

Table A005-3 Geographical Gazetteer

	Place Name	L	φ	Identification
	Outer Circle			
1	Makka Mubārak	77;10	21;40	Mecca
2	Madīnat Rusūl	75;20	25;0	Medina
3	Iskandariyya	61;54	30;58	Alexandria
4	Miṣr	63;20	30;20	Cairo
5	Yaman	77;0	14;30	Ṣanaᶜā’
6	Ṭāᶜif	77;30	21;20	Tā’if
7	Bayt al-Maqdis	66;30	31;50	Jerusalem
8	Dimashq	70;0	33;15	Damascus
9	Anṭākiyya	71;26	35;30	Antiochus
10	Ḥalab	72;10	35;50	Aleppo
11	Qusṭanṭiyya	59;50	45;0	Istanbul
12	Anīth Madīnat al-Ḥikmā’	65;40	37;20	Athens
13	Mawṣil	77;0	34;30	Mosul
14	Ardabīl	82;30	38;0	Ardabil
15	Marāgha	82;0	37;33	Maragha
16	Tabrīz	82;0	38;0	Tabrīz
17	Bulghār	90;0	49;30	(Bulgars)
18	Kūfa	79;30	31;30	Kufa
19	Baṣra	84;0	30;0	Basra

	Place Name	L	φ	Identification
20	Baghdād	80;30	33;25	Baghdad
21	ᶜAskar Mukram	54;30	31;15	Band Qir
22	Kāzirūn	87;0	29;55	Kazerun
23	Sābūr	86;55	30;0	Shapur
24	Shīrāz	88;0	29;36	Shiraz
25	Yazd	89;0	32;30	Yazd
26	Hamadān	83;0	35;10	Hamadan
27	Qazwīn	85;0	36;55	Qazwin
28	Iṣfahān	86;40	32;25	Esfahan
29	Kāshān	86;0	34;0	Kashan
30	Rayy	86;20	35;0	Shahr Rayy
31	Ṭāliqān	85;45	36;10	Taliq-an
32	Astarābād	89;30	36;50	Gotgan
33	Jurjān	92;0	36;50	Jurjan
34	Basṭām	89;30	36;10	Bastam
35	Sabzwar	91;30	36;5	Sabzevar
36	Nīshābūr	92;30	36;21	Neyshabur
37	Ṭūs	94;30	37;0	Tus
38	Harat	94;33	34;30	Herat
39	Sarakhs	94;30	37;0	Sarakhs
40	Fāriyāb	99;0	36;45	Dowlatabad
41	Balkh	101;1	36;41	Wazirabad
42	Badakhshān	104;24	37;10	Faizabad

	Place Name	L	φ	Identification
43	Khuwārizm	94;30	42;17	Kunya-Urgench
44	Bukhārā	97;30	39;50	Bukhara
45	Samarqand	99;16	37;37	Samarqand
46	Khujand	105;30	41;55	Leninabad
47	Kāshghar	106;30	44;0	Kashghar
48	Hurmuz	92;0	25;0	Hormoz
49	Kābul	104;40	34;30	Kabul
50	Mansūra Qaṣba Sind	105;0	27;40	Mansura
51	Sawmnāt	106;0	17;0	Somnath
52	Mūltān	107;35	29;40	Multan
53	Qandahār	106;40	33;0	Qandahar
54	Lahāwar	109;20	31;50	Lahore
55	Qannawj	115;50	26;35	Kannauj
	Inner Circle			
56	Bānārasī	117;20	26;50	Varanasi
57	Sarandīb	130;0	10;0	Sri Lanka
58	Tubbat	110;0	40;0	Lhasa
59	Kashmīr	103;0	35;0	Srinagar
60	Dihlī	114;48	28;17	Delhi
61	Akra	114	27;13	Agra
62	Kawāliyār	115	26;29	Gwalior
63	Ajmīr	111;50	24;0	Ajmer
64	Sulṭān Kūt	109;4	33;0	Sultankot

	Place Name	L	φ	Identification
65[203]	Baran	114;0	28;48	Buland Shahar
66[204]	Siyālkūt	109;4	33;0	Sialkot
65	Kawl	114;19	28;4	Aligarh
66	Sunnām	110;25	30;30	Sunam
67	Pānīpat	113;20	28;52	Panipat
68	Tānīsar	112;35	30;10	Thanesar
69	Budāūn	114;39	27;32	Budaun
70	Sanbhal	115;0	28;4	Sambhal
71	Kura	117;6	26;36	Manikpur
72	Aḥmadābād	108;40	23;15	Ahmedabad
73	Chānpānīr	108;45	22;30	Champaner
74	Kanbāyat	109;40	22;20	Cambay
75	Bījābūr	105;30	17;20	Bijapur
76	Ujjayn	102;0	22;30	Ujjain
77	Amarkūt	105	25	Umarkot
78	Jawnpūr	119;6	26;36	Jaunpur
79	Mānikpūr	118;6	26;49	Garhi Manikpur
80	Hānsī	102;25	29;15	Hansi

203 Not included in Pingree’s list by mistake.

204 Not included in Pingree’s list by mistake.

Figure A005.3 – Back of the astrolabe (accession no. N-69)
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

BACK

On the back, the altitude scales on the rim of the upper half are divided in 5°, 1°, 0;30° and numbered in 5s as 5—90; 90—5.

In the upper left quadrant are drawn 60 horizontal parallels, with each fifth line highlighted with dots, to provide the cosines for each of the 60 parts of the Radius.

In the upper right quadrant are drawn the declination circles; these are labelled along the two radii with the serial numbers of the zodiac signs. On this quadrant are plotted 6 curves for unequal hours which are numbered serially and a sigmoid graph for the meridian altitude of the sun for the latitude of 31;50° (i.e. for Lahore) which carries the label *khaṭṭ zawal ᶜarḍ l.a.n.* (line of noon; latitude 31;50).

In the lower half are shadow squares, on the left for 7 feet and on the right for 12 digits. The vertical and horizontal scales are divided accordingly. In the inner corner on the left is engraved *ẓill sullam aqdām* (scale of shadows in feet). In the inner corner on the right is engraved *ẓill sullam aṣābīᶜ* (scale of shadows in digits). The vertical and horizontal scales on both sides carry the following labels:

Vertical scale on the left:	*zill aqdām maᶜkūs*	(umbra versa in feet),
Horizontal scale on the left:	*zill aqdām mustawī*	(umbra recta in feet),
Horizontal scale on the right:	*zill aṣābīᶜ mustawī*	(umbra recta in digits),
Vertical scale on the right:	*zill aṣābīᶜ maᶜkūs*	(umbra versa in digits).

The rim of the lower half carries the corresponding cotangent scales in feet (*zill aqdām*) and in digits (*zill aṣābīᶜ*). Inside these scales are inscribed the names of the zodiac signs and the corresponding lunar mansions in two semi-circular rows.

ALIDADE

Uninscribed, one of the sights is missing.

INSCRIPTION

Just above the semi-circular rows displaying the zodiac signs and the lunar mansions, there are three lines of inscription which read:

sanah 1009
ṣanaᶜahu aḍaᶜaf al-ᶜibād ᶜīsā wald allāhdād
asṭurlābī lāhūrī humāyūnī tā'rīkh shaḥr dhū 'l-ḥijja.

'[In] the year 1009,
made [by] the weakest of the servants [of God], ᶜĪsā the son of Allāhdād of Lahore,
the astrolabe-maker to [Emperor] Humāyūn, [on the] date [? in the] month Dhū'l-ḥijja.'

Here only the month is mentioned, but not the date. The month *Dhū'l-ḥjja* in AH 1009 lasted from 2 June to 30 June 1601, during which period the astrolabe was made.

BIBLIOGRAPHY

Pingree 2009, no. 13, pp. 52-57.

A006⊙ ASTROLABE BY ᶜĪSĀ, AH 1013 (AD 1604-5)[205]

Diameter 120 mm

Chicago, Adler Planetarium & Astronomy Museum (#A-79)

CCA1076= CCA 3824[206]; Répertoire 2

Figure A006.1 – Front of the astrolabe (accession no. A-79)
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

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205 Entry baed on Pingree 2009, no. 14, pp. 58-63.

206 By mistake CCA lists it twice, but both are identical.

The rete in this astrolabe has an unusual design where the two circles of the Tropic of Capricorn and the ecliptic are held together by the equinoctial bar without any counter change. Below the ecliptic, two semicircular rings are attached to the ring of the Capricorn symmetrically on either side of the meridian to serve as the bases for the star pointers. Pingree calls this rete 'a late addition', implying that it is not original. However, the discovery of another astrolabe with exactly the same type of rete, which will be described presently (A008), suggests that same type of rete could not have been added as replacement in two different astrolabes. On the contrary, this unusual rete may have been one of the designs with which ᶜĪsā has been experimenting. At the beginning of the seventeenth century, the style of the Lahore astrolabes was still in a state of development and has not yet been standardized. Just as the patriarch Allāhdād was experimenting with two styles of rete, his son ᶜĪsā too must be trying different styles of retes. The unusual style of rete seen here and in A007 was one such experiment which was not continued later on.

COMPONENTS

Body with crown (d. 120, h. 150, t. 10), shackle and ring, rete for 23 stars, 8 plates, un-inscribed alidade, pin, wedge.

FRONT

Plain ring with a circular cross-section; the shackle trifoliate but with plain bases. The *kursī* is solid with plain surfaces, with lobed and scalloped profiles and a trifoliate finial. The degree scale on the limb is divided in 1° and 5° and numbered in 5s from 5 to 360.

RETE

The 23 star pointers are shaped, in most cases, like daggers with handles. The ecliptic ring is divided into the 12 zodiac signs and labelled with their names; each sign is subdivided into units of 6°, but not numbered.

The star names are engraved on the pointers very clearly, but they are drastically abbreviated to fit in the limited space available. In the following table, the stars are rearranged in the order of increasing right ascension, starting from the vernal equinox.

Table A006-1 Stars on the Rete

	Star name	Identification
01	*Dhanab Qayṭus*	β Ceti[207]
02	*Fam Qayṭus*	γ Ceti
03	*ᶜAyn al-Thawr*	α Tauri
04	*ᶜAyyūq*	α Aurigae
05	*Rijl al-Jawjā'*	β Orionis
06	*Yad al-Jawzā'*	α Orionis
07	*Yamānī*	α Canis Majoris
08	*Shāmī*	α Canis Minoris
09	*Fard al-Shujāᶜ*	α Hydrae
10	*Qalb al-Asad*	α Leonis
11	*Simāk Aᶜzal*	α Virginis
12	*Rāmiḥ*	α Bootis
13	*Nayyir al-Fakka*	α Coronae Borealis
14	*Ḥayya*	α Serpentis
15	*Qalb al-ᶜAqrab*	α Scorpii
16	*Ḥawwā'*	α Ophiuchi
17	*Wāqiᶜ*	α Lyrae
18	*Ṭā'ir*	α Aquilae
19	*Ridf*	α Cygni
20	*Fam*	ε Pegasi
21	*Sāq Sākib al-Mā'*	δ Aquarii

[207] Pingree 2009, p. 60, identifies this star as ι Ceti, but as it is situated in the sign of Aries, it should be β Ceti (*Dhanab Qayṭus Janūbī*) and not ι Ceti (*Dhanab Qaytus Shamālī*).

	Star name	Identification
22	*Mankib*	β Pegasi
23	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

The astrolabe is equipped with 8 plates. According to Pingree, only three of (numbered 1, 2, 3 below) these are original and the rest are replacements. Pingree does not adduce any reason why he considers the plates 4-8 replacements. No substantial stylistic difference can be seen between the two sets. Moreover, the tablet of ecliptic coordinates and plates carrying double projections for 90° and 0° occur also in ᶜĪsā's undated astrolabe (A009). All the plates have notches at the north point to fit into the corresponding tab in the body.

Table A006-2 Plates

	φ	Longest day
1a	28°	13 hours
1b	29°	13 hours
2a	31°	14 hours
2b	33°	14 hours
3a	34°	14 hours
3b	35°	14 hours
4a	27°	13;27 hours
4b	32°	14;18 hours
5a	36°	14;30 hours
5b	Tablet of ecliptic coordinates	
6a	40°	14;54 hours
6b	45°	15;30 hours

	φ	Longest day
7a	Tablet of horizons 1	
7b	Tablet of horizons 2	
8a	Double projection for 0° and 90°	
8b	Double projection for 18° and 72°	

On plates 1-3, altitude circles are drawn for every 3°, but there are no azimuth arcs. These plates carry lines for seasonal hours and for equal hours drawn from the western horizon and numbered from 1 to 12. On plate 3, the lines for equal hours are dotted. On these plates the duration of the longest day is giving in hours only, omitting the minutes.

Plates 4ab, 5a, 6ab have altitude circles for every 6°. Plates 4ab and 5b have azimuths arcs drawn above and below the horizon for every 10°; on plate 6, these are drawn only below the horizon. Plates 4 and 6 carry lines for seasonal hours and dotted lines for equal hours drawn from the western and eastern horizons up to the meridian and numbered from 1 to 12. On plate 5a, plain lines are drawn for equal hours and dotted lines for equal hours from the western horizon.

Tablet of ecliptic coordinates

On plate 5b is engraved the tablet of ecliptic coordinates. The label *mīzān al-ᶜankabūt* is engraved at the bottom, once each on either side of the meridian line. The ecliptic circle is divided into 12 signs and labelled with their names. Altitude circles are drawn for every 6°. Inside the ecliptic circle, there are numbered, along the meridian, from 6 up to 90, starting at the top and reaching up to the centre of the plate; between circles of the ecliptic and of the equator as 6, 12, 18 and between the circles of the equator and Capricorn as 6, 12, 18, 24. Azimuth circles are also drawn for 6° and numbered from 6 to 30, separately in each zodiac sign.

Two tablets of horizons

On both sides of plate 7, half horizons are engraved for each degree of latitude from 3° to 66°. These are arranged in four sets on each side; on one side are horizons

for latitudes bearing odd number of degrees and on the other face for latitudes with even degrees. The horizons are numbered at both ends; there are declination scales along the four radii. In each set the horizons are arranged at intervals of 8° of latitude as shown below.

Table A006-3

Plate 7a							
4	12	20	28	36	44	52	60
6	14	22	30	38	46	54	62
8	16	24	32	40	48	56	64
10	18	26	34	42	50	58	66

Table A006-4

Plate 7b							
3	11	19	27	35	43	51	59
5	13	21	29	37	45	53	61
7	15	23	31	39	47	55	63
9	17	25	33	41	49	57	65

Plate for the Latitudes 0° and 90°

Plate 8a carries projections for the two latitudes of 0° and 90°.[208] This is the first time such projections were attempted to serve didactic purposes. The upper half shows projections for the latitude 0° and the lower half for 90°. On this plate are drawn the

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208 Pingree 2009, p. 59, says: 'The last tympan bears on one side a projection for a latitude of 90°;' but it is a combined projection for 90° and 0°.

vertical and horizontal diameters and the concentric circles of the two tropics and the equator. The equator is represented by a dotted circle.

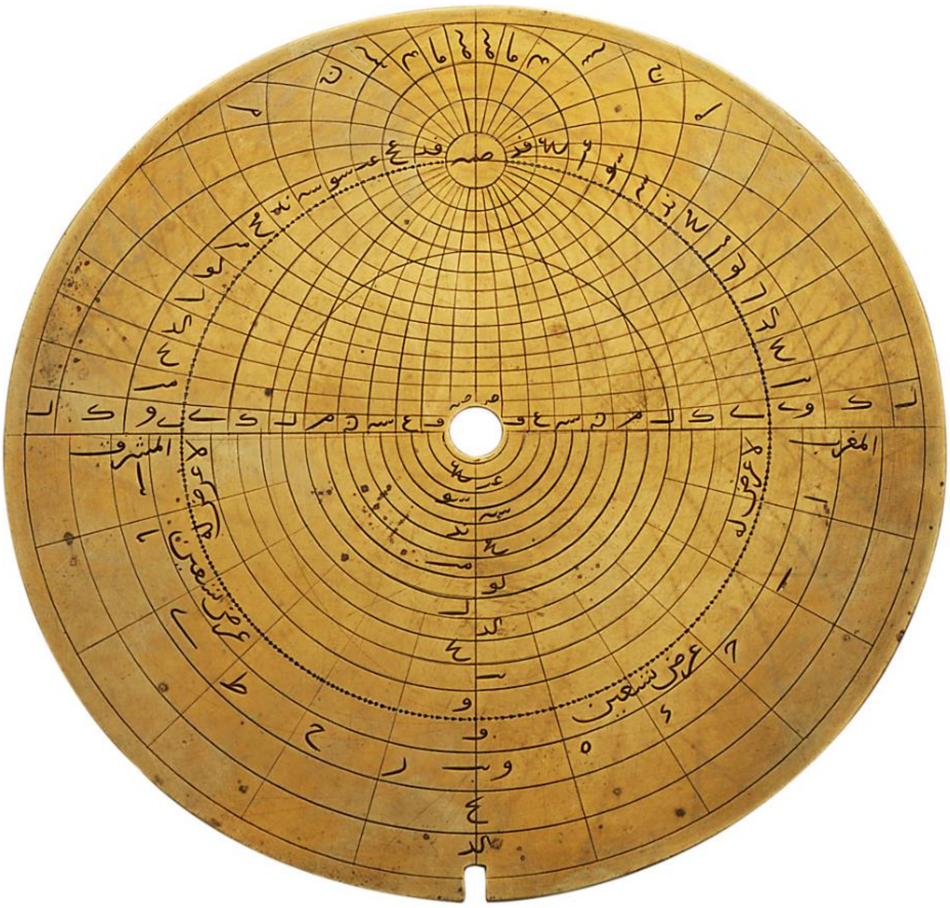

Figure A006.2 – Plate for latitudes 0° and 90° (accession no. A-79)
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

The upper half carries projections for latitude of 0°, i.e. the equator. Here the zenith lies on the equatorial circle and the horizon becomes a line of diameter. Altitude circles are marked above the horizon for every 6° and numbered along the equatorial circle on both sides of the meridian. Azimuth circles, radiating from the zenith, are drawn for every 10° and numbered above the line of horizon from 10 to 90 inside the circle of equator and once again outside the circle of equator, starting above the line of horizon and continuing up to the top of the plate.

In the lower half are the projections for the latitude of 90°, i.e., the North Pole. Here the altitude circles, drawn for every 6°, merge with the declination circles and the

azimuth circles, drawn for every 10°, merge with the hour lines. Because, 'at the pole the altitude of an object is equal to its declination and its hour angle is the hour line'. [209]

Here the altitude circles are numbered along the meridian; once inside the equatorial circle from 0 to 90, starting from the equatorial circle up to the centre of the plate; and again outside the equatorial circle from 6 to 24 reaching up to the circle of Capricorn. The azimuth circles / hour lines are numbered from 1 to 12, from the western horizon to the eastern, along one of the altitude circles.

Under the western horizon is written *al-maghrib* and under the eastern horizon *al-mashriq.* Immediately below the dotted circle of equator is written *ᶜarḍ tisᶜīn* (latitude 90) on both sides of the meridian. Just inside the dotted circle of equator and below the line of horizon is written *lā ᶜarḍ lahu* (no latitude) again on both the sides of the meridian.

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[209] Morrison 2007, p. 65.

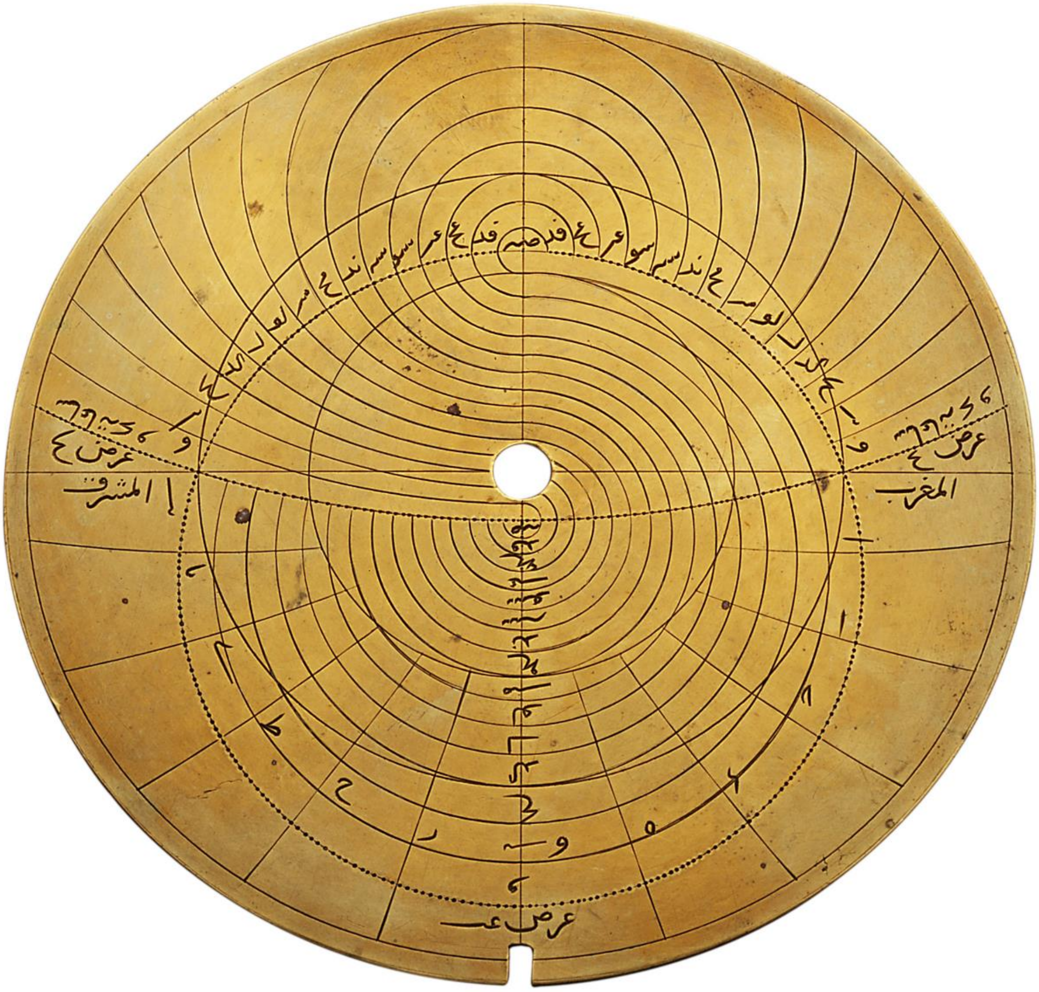

Figure A006.3 – Plate for Latitudes 18° and 72° (accession no. A-79)
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

Plate for the Latitudes 72° and 18°

Plate 8b has a combined projection for the latitudes 18° and 72°, resulting in S-shaped curves.[210] This is again the first attempt at the combined projection. On this plate are drawn the vertical and horizontal diameters, concentric circles of the tropics and the equator; furthermore, a dotted curve of the oblique horizon at latitude 18° and a dotted circle of the prime vertical. In the upper half, the altitude circles are drawn for every 6° and numbered along the dotted circle of the prime vertical on both sides of the meridian

[210] Pingree 2009, p. 59, remarks that ‘this is similar to a projection on tympan belonging to an astrolabe in the Benaki Museum in Athens (Inv.No. 13178)’, but such projections occur in several Lahore astrolabes and also in Rāghavajit’s Sanskrit astrolabe of 1669 (C008).

line. In the lower half also the altitude circles are drawn for every 6° and numbered from the prime vertical to the centre of the plate from 6 to 90 along the line of the meridian.

Just below the prime vertical at the north point is the label *ᶜarḍ 72* (latitude 72). Under the straight horizon in the east is the label *al-mashriq* and in the west *al-maghrib*. Between the straight horizon and the oblique horizon is written *ᶜarḍ 18* (latitude 18) both in the east and west. And just above the oblique horizon is the label *sāᶜāt 13;6* (13;6 hours) both in the east and in the west. This is the duration of the longest day at latitude 18°.

Geographical Gazetteer

On the inner surface of the mater, a geographical gazetteer is engraved in two concentric circles, providing the names (*asmā' al-buldān*), longitudes (*al-ṭūl*) and latitudes (*al-ᶜarḍ*) of 70 places. But very few towns from the Indian subcontinent are included here; Multan (67), Lahore (69) and Kashmir (70) are mentioned, but not Agra or Delhi. In each circle, the data is arranged from the right to the left proceeding counter-clockwise. As in the previous astrolabe, here also the symbol for zero is much smaller than the other letters.

Figure A006.4 – Geographical Gazetteer (accession no. A-79)
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

Table A006-5 Geographical Gazetteer

	Place Name	L	φ	Identification
	Outer Circle			

	Place Name	L	φ	Identification
01	Makka Mubārak	77;10	21;40	Mecca
02	Madīnat Rasūl	75;29	25;00	Medina
03	Tā'if	77;30	21;20	Tā'if
04	Tihāma	82;30	23;0	Yamāma
05	Hajar Baḥrayn	83;0	25;15	Manāmah
06	Dimashq	70;0	33;15	Damascus
07	Baᶜalbak	70;15	33;15	Baᶜalbaek
08	Ḥimṣ	70;15	34;0	Homs
09	Ḥalab	72;10	35;50	Aleppo
10	Ṭarsūs	68;40	36;42	Tarsus
11	Rūmiyya Kubrā	45;27	41;50	Roma
12	Madīnat al-Ḥukumā'	65;40	37;20	Athens
13	Qusṭanṭiyya	59;50	45;00	Istanbul
14	Mawṣil	77;0	34;30	Mosul
15	Nakhjawān	81;15	38;0	Nakhichevan
16	Marāgha	82;0	37;20	Marāgheh
17	Tabrīz	82;0	38;0	Tabriz
18	Ardabīl	82;30	38;0	Ardabil
19	Mūqān	83;0	38;0	
20	Bāb al-Abwāb	85;0	43;0	Darbent
21	Bulghār	90;0	59;30	(Bulgars)
22	Kūfa	79;30	31;30	Kufah
23	Madā'in	72;0	33;10	Ctesiphon

	Place Name	L	φ	Identification
24	Baghdād	80;30	33;25	Baghdad
25	Wasiṭ	81;30	30;20	Wasit
26	Baṣra	84;0	30;0	Basra
27	ᶜAbbādān	84;30	30;0	Abadan
28	Kāzīrūn	86;0	39;15	Kazerun
29	Shīrāz	88;0	29;36	Shiraz
30	Iṣṭakhr	88;30	30;0	Takhṭ-e Jamshīd
31	Yazd	89;0	32;30	Yazd
32	Shahrūr	82;20	32;30	Shahrazur
33	Nihāwand Mā al-Baṣra	83;15	34;30	Nahavand
34	Zankān	83;40	36;30	Zanjan
35	Hamadān	83;0	35;10	Hamadan
36	Sāwa	85;0	35;0	Sāveh
37	Karaj	84;45	30;0	Karaj
38	Qazwīn	85;0	36;55	Qazwin
39	Iṣfahān	86;40	32;25	Esfahan
40	Kāshān	86;0	34;0	Kashan
41	Qumm	86;40	34;45	Qom
42	Rayy	86;20	35;0	Shahr Rey
43	Ṭāliqān	85;41	36;10	Taliq-an
44	Hawsam az-Jīlān	85;10	37;0	
45	Astarābād	89;30	36;50	Gorgān
46	Jurjān	90;0	37;50	Jurjān

	Place Name	L	φ	Identification
47	Simnān	88;0	36;0	Semnan
	Inner Circle			
48	Basṭām	81;30	36;10	Bastam
49	Sabzwar	91;30	36;5	Sabzevar
50	Nīshābūr	92;30	36;21	Neyshabur
51	Ṭūs	94;30	37;0	Tus
52	Qāyin	93;13	33;40	Qāyen
53	Zūzan	93;30	35;20	Zuzan
54	Harāt	94;13	34;30	Heart
55	Sarakhs	94;30	36;0	Sarakhs
56	Marw	97;0	37	Mary
57	Balkh	101;0	36;41	Wazirabad
58	Badakhshān	104;24	37;10	Faizabad
59	Bukhārā	97;30	39;50	Bukhara
60	Samarqand	99;16	39;37	Samarqand
61	Kābul	104;40	34;30	Kabul
62	Kāshghar	106;30	44;0	Kashgar
63	Khutan	107;0	42;0	Khotan
64	Hurmūz	92;0	25;0	Hormoz
65	Khabīṣ	93;0	31;0	Shadab
66	Daybul Hiyya Tāttah	102;7	25;10	Tatta
67	Multān	107;35	29;40	Multan
68	Qandahār	106;40	33;0	Kandahar
69	Lahāwar	109;20	31;50	Lahore

	Place Name	L	φ	Identification
70	Kashmīr	108;0	35;0	Srinagar

BACK

The rim of the two upper quadrants carries the altitude scales, divided in 1° and 5° and numbered 5—90; 90—5.

The upper left quadrant bears a trigonometric quadrant with 60 horizontal equidistant parallels, each fifth dotted, showing cosines for each of the 60 parts of the Radius.

In the upper right quadrant, there are declination arcs which divide the quadrant into 6 zones, one for each pair of opposite signs of zodiac, which are numbered along the radii. On this quadrant are plotted 6 curves for unequal hours which are numbered serially and the sigmoid graph for the meridian altitude of the sun for the latitude of 31;50° (i.e. for Lahore) with the label *khaṭṭ niṣf al-nahār ᶜarḍ 31;50* (line of midday; latitude 31;50).

Figure A006.5 – Back View of the Astrolabe (accession no. A-79)
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

In the lower half are shadow squares, on the left for 7 feet and on the right for 12 digits. The scales are divided and the divisions numbered accordingly.

In the inner corner on the left is engraved *sullam aqdām* (scale in feet). The vertical scale on the left is labelled as *aqdām maᶜkūs* (reverse [shadow] in feet) and the horizontal scale *aqdām mustawī* (direct [shadows] in feet).

In the inner corner on the right is engraved *sullam aṣābīᶜ* (scale in digits). The vertical scale on the right is labelled as *aṣābīᶜ maᶜkūs* (reverse [shadow] in digits) and the horizontal scale *aṣābīᶜ mustawī* (direct [shadows] in digits]).

The rim of the lower half carries the corresponding scales of cotangents; on the left for 7 feet with the label *ẓill aqdām* (shadows in feet) and the end and on the right for 12 digits with the label *ẓill aṣābīᶜ* (shallows in digits).

Below the shadow squares and adjacent to the circular cotangent scale are two semicircles bearing the names of the zodiac signs and the corresponding lunar mansions.

Alidade

The alidade is not graduated. One half of the wedge is curved terminating in a large circle; the other half is straight with the end tapering to a point.

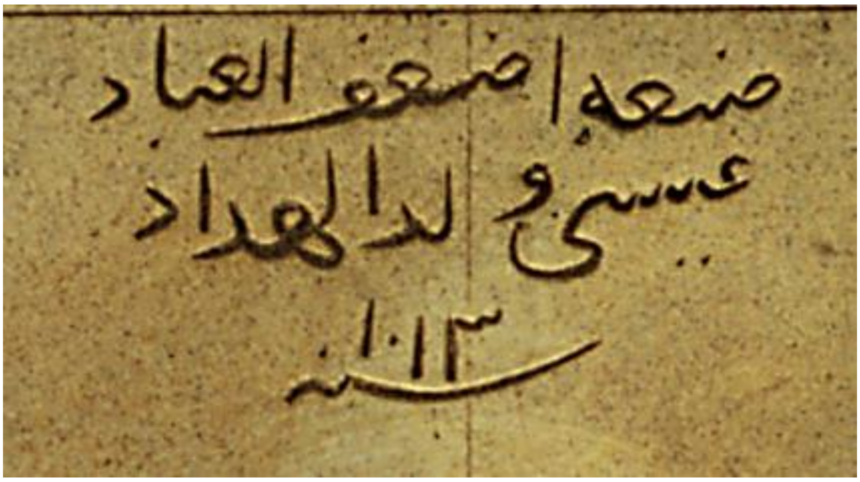

Figure A006.6 – Signature of the astrolabe maker (detail of Figure A006.5)

Inscription

Inside the shadow squares, at the centre, is engraved upside down the following inscription in three lines:

ṣanaᶜahu aḍᶜaf al-ᶜibād

ᶜīsā wald allāhdād

sanah 1013.

‘Made [by] the weakest of the servants [of God], ᶜĪsā the son of Allāhdād, in the year 1013.’ The year corresponds to AD 1604-5.

Bibliography

Pingree 2009, no. 14, pp. 58-63.

A007⊙ ASTROLABE, UNDATED, BY ᶜĪSĀ[211]

Not dated, ca. 1600, Lahore

Diameter 262 mm

UK, Ely, Cambs, PC

CCA 68 = CCA 3825[212]; Répertoire 3

Figure A007.1 – Front of the astrolabe (photo courtesy the owner)

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211 Entry based mainly on the photos kindly provided by the owner.

212 By mistake, CCA lists it twice, both are identical.

COMPONENTS

Body with crown (d. 262, h. 337, t. 14), shackle and ring, rete, 5 plates, alidade, washer, pin and wedge.

FRONT

The ring, shackle and the *kursī* are almost like those in the previous two astrolabes. The *kursī,* lobed with a trifoliate finial, has a plain unadorned surface.

The degree scale on the limb is graduated for 0;30°, 1°, 5° and numbered clockwise in 5s from 5 to 360.

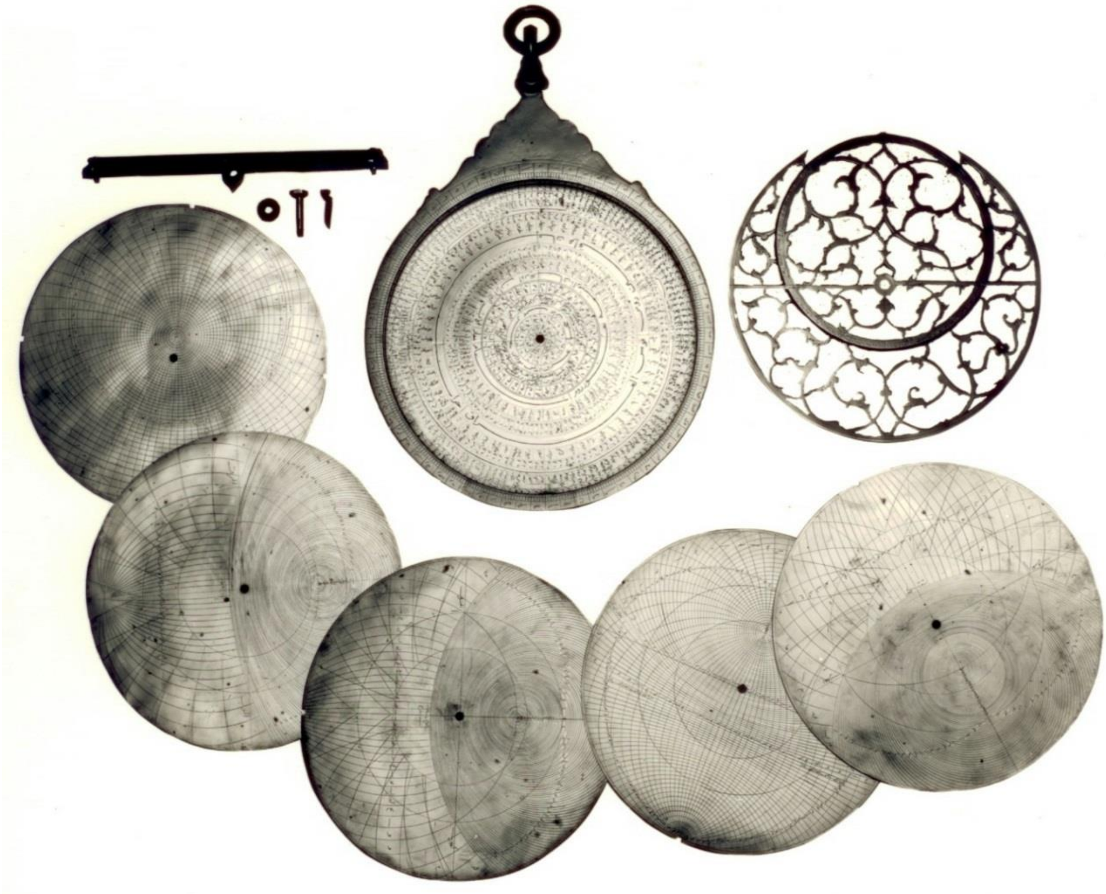

Figure A007.2 – All components of the cstrolabe (photo courtesy the owner)

RETE

The two narrow rings of the Tropic of Capricorn and the ecliptic are held together by a narrow equinoctial bar which has a counter-change at the centre. The space between the two rings and that inside the ecliptic ring is filled by an almost symmetrical floriate tracery. The ecliptic ring is divided into the 12 signs of the zodiac and labelled; each sign is divided in units of 6° each and numbered as 6, 12, 18, 24, 30 in counter-clockwise

direction. There is a handle to rotate the rete. There are some 59 star pointers. Their names cannot be completely deciphered from the available photos.

PLATES

There are 5 plates serving the latitudes 18° and 29°; 27° and 32°; 37° and 40°; 0° and 24°+30°; tablet of ecliptic coordinates and tablet of horizons. The plates have notches at the north point to fit into the corresponding tab in the body. Altitude circles are drawn for every degree and numbered. Azimuths are drawn below the horizon for every 10º. Lines are drawn for seasonal hours and equal hours since the sunset and before the sunrise.

GEOGRAPHICAL GAZETTEER

On the inner surface of the mater is engraved a geographical gazetteer in four concentric circles. The table contains the names, latitudes and longitudes of some 176 localities, arranged according to regions. The names of the regions are engraved with long circular flourishes in the spaces between the circles. The gazetteer could not be deciphered from the available photo.

BACK

The rim of the two upper quadrants is divided in 0;30°, 1° and 5° and labelled as 5—90; 90—5.

In the upper left quadrant is a trigonometric quadrant with 60 horizontal parallels. The upper right quadrant is divided by the declination arcs into 6 zones, one each for an opposite pair of zodiac signs which are indicated by serial numbers along the two radii. On this quadrant are drawn six curves for the unequal hours. There is no sigmoid graph of the midday altitude of the sun as in his two other astrolabes.

In the lower half are two small shadow squares, on the left for 7 feet and on the right for 12 digits. The scales are divided and numbered accordingly. The scales carry appropriate labels.

The rim on the lower half bears the cotangent scales. Inside these scales, the names of the zodiac signs and the names of the corresponding lunar mansions are engraved in two semi-circular rows as in the previous two astrolabes.

ALIDADE

The alidade is a straight bar alidade with two sights but no graduations on it. There is a pin with an octagonal head, a washer and a wedge with horse's head

INSCRIPTION

Below the shadow squares is the signature of the astrolabe maker in two lines:

ṣanacahu aḍacaf al-cibād cīsā ibn allāhdād

asṭurlābī lāhūrī humāyūnī

'Made by the weakest of the servants [of God], ᶜĪsā the son of Allāhdād of Lahore, the astrolabe maker of [Emperor] Humāyūn.'

Provenance

Sotheby's London, 2 May 1977, Lot 257.

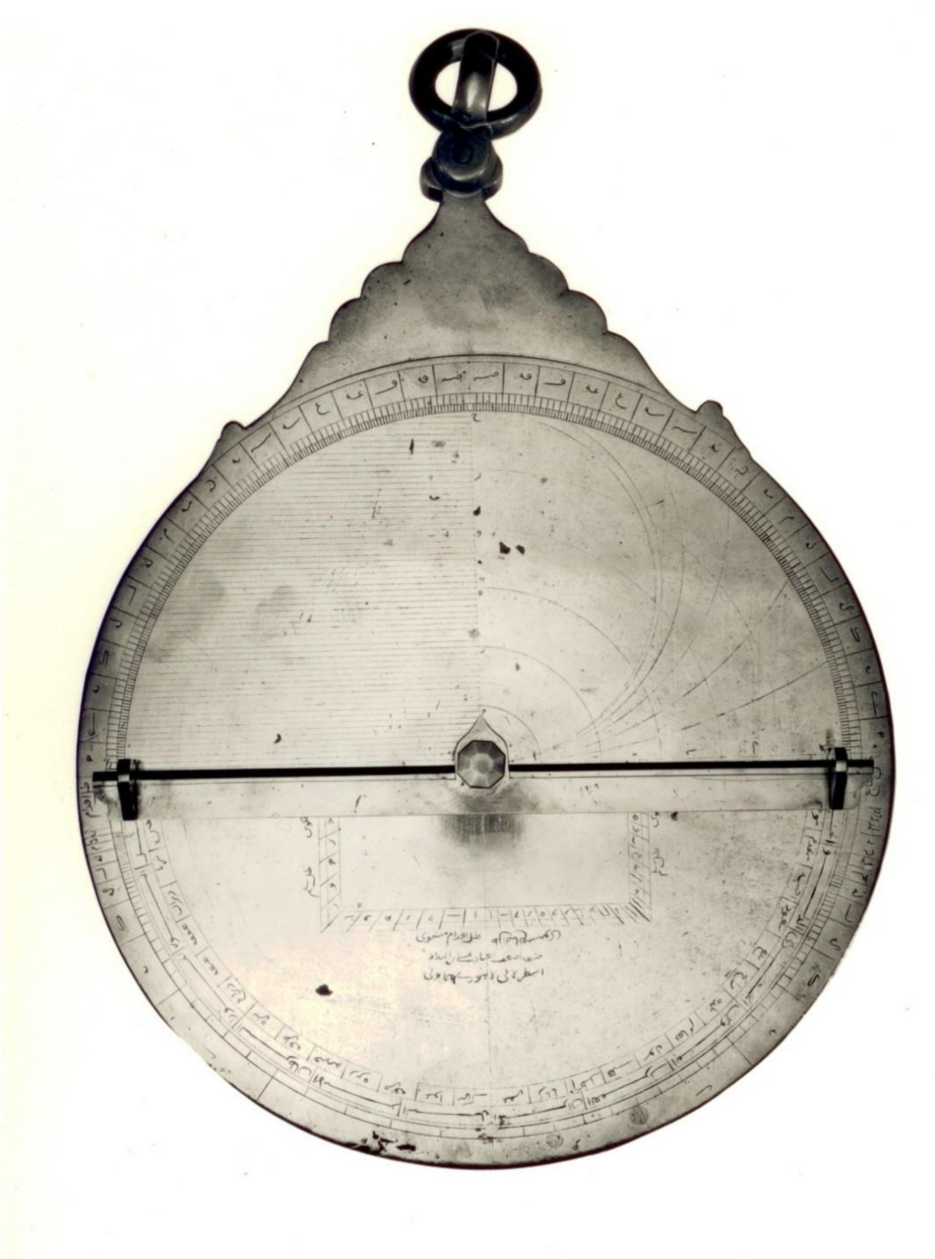

Figure A007.3 – Back of the astrolabe (photo courtesy the Owner)

BIBLIOGRAPHY

Gunther 1932, no. 68

Wynter & Turner 1975, pp. 16-18, figs. 9, 10 and 11.

A008 ASTROLABE ATTRIBUTABLE TO ᶜĪSĀ

Not dated, 17th century

Diameter 119 mm

PLU

Figure A008.1 – Front of the astrolabe (photo courtesy Museum of the History of Science, Oxford)

In the archives of the Museum of the History of Science at Oxford, there are two photos of the front and back of the astrolabe, and photocopies of all the components, plus a typed note signed by Francis Maddison on 10.xii.85.[213]

It has a very close resemblance to the astrolabe of 1604 by ᶜĪsā (A006). The size is the same. The *kursī,* the degree scale on the front and the entire configuration on the back is also the same. The unusual design of the rete is the same. In both the astrolabes, the gazetteer covers the same set of 70 localities in the same order and with the same coordinates.

There are also certain differences. In A006, the ecliptic ring in the rete is divided into 6° but not numbered; here it is divided in 2° and 6° and numbered in 6s from 6 to 30, separately in each sign. In this astrolabe, the labels in the degree scales on the front and at the back and the place names in the gazetteer are enclosed in arches. A006 contains 8 plates, but this one only 6 plates. It is not known whether there was space for 8 plates in the present astrolabe and two are missing. Finally, although the contents of the gazetteers are the same, the gazetteer in the present astrolabe displays a totally different calligraphy. It is difficult to decide whether it was made by ᶜĪsā himself at the beginning of the seventeenth century or whether it is an exact copy fabricated at a later period. I am inclined to the first possibility. At the beginning of the seventeenth century, the style of the Lahore astrolabes has not yet been standardized. Just as the patriarch Allāhdād was experimenting with two styles of rete, his son ᶜĪsā too must be trying different styles of retes.

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213 At the top of the note is written by hand 'Sotheby'. Obviously the astrolabe was sent by Sotheby's to Maddison for his evaluation which reads as follows:'Indo-Persian Astrolabe; not signed, dated, on the back of the suspension bracket, 'The hijrî year 1135 [= A. D. 1722/3]'; brass, diam. 119 mm, thickness 10 mm.'Rete for 18 named stars and 6 unnamed star-pointers. 5 plates [sic! the photocopies show 6 plates]: for latitudes 18°, 29°; 31°, 33°; 36°, tablet of ecliptic coordinates; 2 tablets of horizons; a composite plate of special projections. In the mater there is a gazetteer of the longitudes and latitudes of 69 places (plus one place-name without coordinates). On the back is a sine quadrant; a graph of the meridian altitude of the sun for latitude 31° (?Lahore); a shadow-square; an astrological table; and scales of cotangents. The horse, pin, and washer appear to be original.
'An attractive and well-made astrolabe continuing the tradition of plain but complete astrolabes of the well-known seventeenth-century makers of Lahore. Somewhat massive for its size, there is a pleasing arch decoration around the gazetteer and degree scales.'
FRM/10:xii:'85.
The astrolabe came up for auction at Sotheby's on 25 March 1986; see catalogue of this date, lot 101. The description reproduces Maddison's second paragraph verbatim.

The unusual style of rete seen in A006 and in the present astrolabe was one experiment which was not continued later on. The same is the case with the decorative arches in the degree scales and in the gazetteer. This too was not continued in subsequent astrolabes. The geographical gazetteer in the present astrolabe must have been engraved by an assistant in ᶜĪsā's workshop, hence the difference in calligraphy.

COMPONENTS

Body with *kursī* (d. 119, t. 10), shackle, ring, rete, alidade, pin and horse.

FRONT

The *kursī* is solid with lobed profiles. On back of the *kursī* is a carelessly scratched inscription *asṭurlāb 1135 hijrī* ((= AD 1722-23). This must have been added by one of the owners.

The limb is divided in 1° and 5° and numbered from 5 to 360. These numbers are enclosed inside arches.

RETE

As mentioned above, the rete is exactly like the rete in the astrolabe by ᶜĪsā of 1604 (A006) and contains the same 23 named star-pointers.

Table A008-1 Stars on the Rete

	Star name	Identification
01	*Dhanab Qayṭus*	β Ceti
02	*Fam Qayṭus*	γ Ceti
03	*ᶜAyn al-Thawr*	α Tauri
04	*ᶜAyyūq*	α Aurigae
05	*Rijl al-Jawjā'*	β Orionis
06	*Yad al-Jawzā'*	α Orionis
07	*Yamānī*	α Canis Majoris
08	*Shāmī*	α Canis Minoris
09	*Fard al-Shujāᶜ*	α Hydrae

	Star name	Identification
10	*Qalb al-Asad*	α Leonis
11	*Simāk Aᶜzal*	α Virginis
12	*Rāmiḥ*	α Bootis
13	*Nayyir al-fakka*	α Coronae Borealis
14	*Ḥayya*	α Serpentis
15	*Qalb al-ᶜAqrab*	α Scorpii
16	*Ḥawwā’*	α Ophiuchi
17	*Wāqiᶜ*	α Lyrae
18	*Ṭā’ir*	α Aquilae
19	*Ridf*	α Cygni
20	*Fam*	ε Pegasi
21	*Sāq Sākib al-Mā’*	δ Aquarii
22	*Mankib*	β Pegasi
23	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are six plates.

Table A008-2 Plates

	φ	Longest Day
1a	18°	13 hours
1b	29°	13 hours
2a	31°	14 hours
2b	33°	14 hours
3a	36?	? hours

	φ	Longest Day
3b	40°	14 hours
4a	34?	14 hours
4b	Tablet of ecliptic coordinates	
5a	Double projection for 0° + 90°	
5b	Triple projection for 0°+ 90°+ 72°	
6a	Tablet of horizons 1	
6b	Tablet of horizons 2	

Geographical Gazetteer

The geographical gazetteer engraved on the inner side of the mater provides the names, longitudes and latitudes of 70 localities. Here also the place names are enclosed in arches as on the limb. The gazetteer is nearly identical to the gazetteer in A006, except minor differences in nos. 30 and 33.

Table A008-3 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
01	Makka Mubārak	77;10	21;40
02	Madīnat Rasūl	75;29	25;00
03	Tā’if	77;30	21;20
04	Yamāma	82;30	23;0
05	Hajar Baḥrayn	83;0	25;15
06	Dimashq	70;0	33;15
07	Baᶜalbak	70;15	33;15

	Place Name	L	φ
08	Ḥimṣ	70;15	34;0
09	Ḥalab	72;10	35;50
10	Ṭarsūs	68;40	36;42
11	Rūmiyya Kubrā	45;27	41;50
12	Madīnat al-Ḥukumā’	65;40	37;20
13	Qusṭanṭiyya	59;50	45;00
14	Mawṣil	77;0	34;30
15	Nakhjawān	81;15	38;0
16	Marāgha	82;0	37;20
17	Tabrīz	82;0	38;0
18	Ardabīl	82;30	38;0
19	Mūqān	83;0	38;0
20	Bāb al-Abwāb	85;0	43;0
21	Bulghār	90;0	59;30
22	Kūfa	79;30	31;30
23	Madā’in	72;0	33;10
24	Baghdād	80;30	33;25
25	Wasiṭ	81;30	30;20
26	Baṣra	84;0	30;0
27	ᶜAbbādān	84;30	30;0
28	Kāzīrūn	86;0	39;15
29	Shīrāz	88;0	29;36

	Place Name	L	φ
30	Iṣṭakhr	88;0[214]	30;0
31	Yazd	89;0	32;30
32	Shahrūr	82;20	32;30
33	Nihāwand[215]	83;15	34;30
34	Zankān	83;40	36;30
35	Hamadān	83;0	35;10
36	Sāwa	85;0	35;0
37	Karaj	84;45	30;0
38	Qazwīn	85;0	36;55
39	Iṣfahān	86;40	32;25
40	Kāshān	86;0	34;0
41	Qumm	86;40	34;45
42	Rayy	86;20	35;0
43	Ṭāliqān	85;41	36;10
44	Hawsam az-Jīlān	85;10	37;0
45	Astarābād	89;30	36;50
46	Jurjān	90;0	37;50
47	Simnān	88;0	36;0
	Inner Circle		
48	Basṭām	81;30	36;10
49	Sabzwar	91;30	36;5
50	Nīshābūr	92;30	36;21

214 A006 has the value 88;30.

215 A006 has Nihāwand Māh al-Baṣrah.

	Place Name	L	φ
51	Ṭūs	94;30	37;0
52	Qā’in	93;13	33;40
53	Zūzan	93;30	35;20
54	Harāt	94;13	34;30
55	Sarakhs	94;30	36;0
56	Marw	97;0	37
57	Balkh	101;0	36;41
58	Badakhshān	104;24	37;10
59	Bukhārā	97;30	39;50
60	Samarqand	99;16	39;37
61	Kābul	104;40	34;30
62	Kāshghar	106;30	44;0
63	Khutan	107;0	42;0
64	Hurmūz	92;0	25;0
65	Khabīṣ	93;0	31;0
66	Daybul Hiyya Tāttah	102;7	25;10
67	Multān	107;35	29;40
68	Qandahar	106;40	33;0
69	Lahāwar	109;20	31;50
70	Kashmīr	108;0	35;0

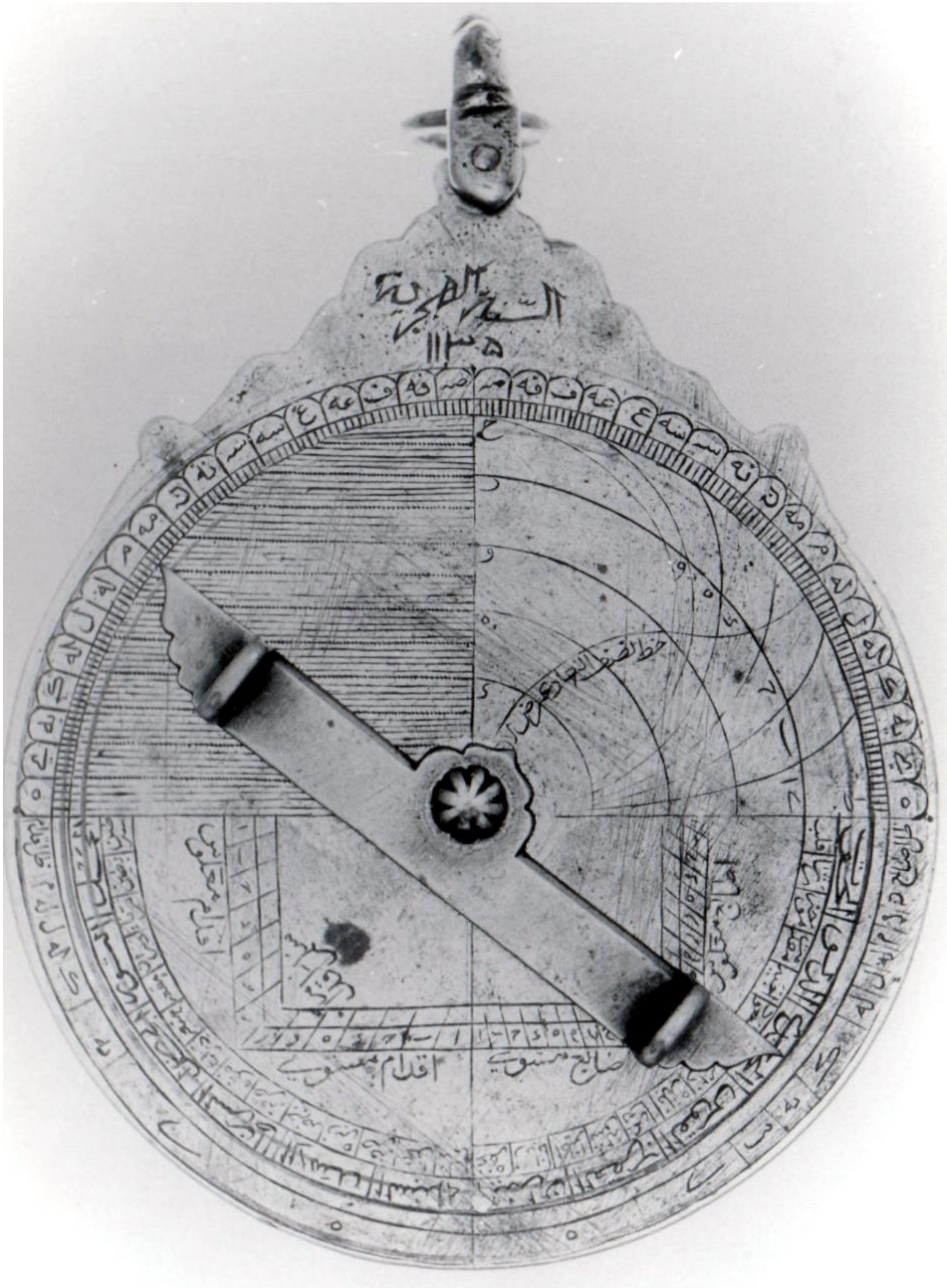

Figure A008.2 – Back of the astrolabe
(photo courtesy Museum of the History of Science, Oxford)

BACK

The rim on the upper half on the back carries altitude scales, divided in 1° and 5° and numbered 6---90; 90---6. As on the limb, here also the numbers are enclosed in arches. The trigonometric quadrant on the upper left is filled with 60 horizontal parallels which show cosines for each of the 60 parts of the Radius. Here every fifth line is dotted.

In the upper right quadrant, declination arcs divide the quadrant into 6 segments, one for each pair of opposite signs of zodiac, which are numbered along the radii. Here

6 curves are drawn for unequal hours which are numbered serially and a sigmoid graph for the meridian altitude of the sun for a latitude of 31;50° (i.e. for Lahore) with the label *khaṭṭ niṣf al-nahār ᶜarḍ l.a.n.* (line of midday; latitude 31;50).

In the lower half are shadow squares, on the left for 7 feet and on the right for 12 digits. The scales are divided and the divisions numbered accordingly. The labels are as in the previous astrolabe.

On the rim of the lower half are cotangent scales. These are followed by two semi-circular rows bearing the names of the zodiac signs and the corresponding lunar mansions.

ALIDADE

The alidade is not graduated.

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QĀ'IM MUḤAMMAD

Qā'im Muḥammad (*fl.* 1624-1635), the elder son of ᶜĪsā, is known through four astrolabes; three others can be attributed to him. He also produced one astrolabe jointly with his younger Muḥammad Muqīm. There is yet another astrolabe in Hannover (A009) which is said to have been produced by the sons of ᶜĪsā (*ibnī ᶜīsā ibn allāhdād*), but it is uncertain whether the inscription is authentic. Qā'im is the first member of the family to produce celestial globes as well, four of which survive today[216] Until this time, celestial globes were produced first as two hollow spheres and then joined together. Qā'im Muḥammad produced them as single hollow spheres by applying the *cire perdue* or lost wax method which had been employed in India for long time in casting bronze statues.

Qā'im's astrolabes and celestial globes carry dates between 1624 and 1637. Thus the period of his activity falls in the reigns of the Mughal emperors Jahāngīr (r. 1605-1627) and Shāh Jahān (r. 1628-1658). On some of his instruments, Qā'im mentions the time of production in the regnal years of Jahāngīr or of Shāh Jahān, in addition to or in lieu of the Hijrī years.

Qā'im enjoyed the patronage of high dignitaries of the Mughal court. In 1622, he made a celestial globe for Nawāb I'tiqād Khān, who was a brother of Nūr Jahān Begum, the queen of Jahāngīr. Five years later, in 1627 he created a fabulous astrolabe for Nawāb Khwājah Abū al-Ḥasan who held many important positions under Jahāngīr, such as the Subahdār of Deccan and the General Paymaster of the Household; only the rete of this astrolabe survives in Patna (A011).

The Lahore astrolabes became more or less standardized in the work of ᶜĪsā. Qā'im made further refinement in the design of the *kursī* and rete, and also introduced certain innovations.

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[216] These four globes are
F001 Celestial Globe by Qā'im 1032/1622-23, d. 188 UK, Blackburn
F002 Celestial Globe by Qā'im 1035/1625-26, d. ? Paris, PC
F003 Celestial Globe by Qā'im J 22/1626-27, d. 156 London, V&A
F004 Celestial Globe by Qā'im 1046/1637-38, d. 173 Patna.
Full descriptions of these globes will appear in section F.

Although four of his astrolabes are known to exist, no details are available about A010 and A012 and in A011 only the rete is extant. Therefore, his work has to evaluated on the basis of the single complete astrolabe A013. Here the rete contains as many as 58 named star pointers. On the latitude plates, in addition to the lines for seasonal and equal hours, there are also, for the first time, lines for the traditional Indian time units of *ghaṭīs* of 24 minutes. In the 7 plates, 5 plate faces carry double projections of two latitudes. The gazetteer is arranged according to the Ptolemaic climates, but commences with the second climate so that the holy cities Mecca and Medina occupy the first places. The rete carries, for the first time, *zawraqī* or ship horizons and there is a special plate to be used with these *zawraqī* horizons.

There are two innovations in this astrolabe which are unique to this astrolabe and are not found in any other astrolabe produced in India. The first is the circle for the visibility of the star *Suhayl* (Canopus) traced on many plates. Second, the back contains a series of completely circular scales including an eccentrically placed *Rūmī* or Syro-Macedonian calendar.

Except these two, the other features mentioned above occur in three unsigned astrolabes A014, A015 and A016, and for this reason these astrolabes can be attributed to Qā'im Muḥammad. In A014, lines for *ghaṭīs* are drawn on many plates; what is new here is that on many plates the maximum duration of daylight is expressed in *ghaṭīs.* Also in common with A013 is the gazetteer commencing with the second climate. A015 is much larger and displays superior workmanship; yet in technical aspects it is exactly like A014 with the same gazetteer and with the plates serving the same latitudes. The third unsigned astrolabe A016 displays splendid workmanship like Qā'im's A011. In its rete, the names of the zodiac signs are cut in silhouette along the rim of the ecliptic almost in the same manner as in A011. It also carries *zawraqī* horizons as in A013.

A009☉ ASTROLABE BY THE TWO SONS OF ᶜĪSĀ, AH 1018 (AD 1609-10)

Diameter 84

Hannover, Kestner-Museum (#1914, 61)

CCA 69; Répertoire lists this astrolabe as Muḥammad Muqīm 1

Figure A009.1 – Front and back of the astrolabe (from Frank & Meyerhof 1925)

This small and rather crude astrolabe was the subject of a very learned and valuable monograph entitled *Ein Astrolab aus dem indischen Mughulreiche* by Josef Frank and Max Meyerhof.[217] The inscription on the *kursī* states that the astrolabe was made by the two sons of ᶜĪsā, the son of Allāhdād (*ibnī ᶜīsā ibn allāhdād*) in 1018 AH (= AD 1609-10) at Lahore. Since Qā'im Muḥammad and Muḥammad Muqīm, the two sons of ᶜĪsā, made a name for themselves as accomplished instrument makers, one is tempted to conclude that the present astrolabe must be a juvenile work by them. But such a conclusion is problematic as there are several layers of engravings on this astrolabe.

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217 Frank & Meyerhof 1925.

Components

Body with *kursī* (d. 84, h. 110, t. 8), shackle and ring, rete (d. 72) for 20 stars, 5 plates, pin; the alidade and wedge can be seen in the photos accompanying the monograph of 1925 by Frank and Meyerhof; but they were not there when I examined the astrolabe in 1996.

Figure A009.2 – All the components of the astrolabe (photo by S. R. Sarma)

Front

Small flattish ring, shackle of trifoliate shape, high solid *kursī* with three lobes on each side and a trifoliate finial. The front and back surfaces of the *kursī* are filled with inscriptions.

The degree scale on the limb is divided in 1° and 5°. The groups of 5° are numbered from 5° to 90° separately for each quadrant in clockwise direction. At the bottom, there is a lug on the meridian at the north point to hold the plates in position.

Rete

The rete is rather crude. The equatorial ring is almost completely represented here unlike in the majority of the Lahore astrolabes. The three rings of the Capricorn, equator and ecliptic are held together by the equinoctial bar which has one counter change at the

centre and by the solstitial bar also with one counter change at the centre. Guide-lines can be discerned at the back of the rete. The ecliptic ring is divided into 12 signs and labelled. Each sign is further subdivided into five units of 6° each, but not numbered. There are 20 star pointers which are listed below.[218]

Table A009-1 Stars on the Rete

	Star Name	Identification
01	*Baṭn Ḥūt*	β Andromedae
02	*Fam al-Qayṭus*	γ Ceti
03	*Rijl Jawjā’ al-Yusrā*	β Orionis
04	*Shi^c^rā Yamānī*	α Canis Majoris
05	*Rās Taw’am*	α Geminorum
06	*Muqaddam Zira ^c^ayn*	β Geminorum
07	*Fard Shujā^c^*	α Hydrae
08	*Qā^c^idat al-Bāṭiya*	α Crateris
09	*Simāk-i A^c^zal*	α Virginis
10	*Simāk Rāmiḥ*	α Bootis
11	*Nayyir Fakka*	α Coronae Borealis
12	*Qalb al-^c^Aqrab*	α Scorpii
13	*Rās al-Jāthī*	α Herculis
14	*Nasr Wāqi^c^*	α Lyrae
15	*Nasr Ṭā’ir*	α Aquilae
16	*Dhanab al-Dajāja*	α Cygni
17	*Dhanab al-Jadī*	δ Capricorni
18	*Sāq*	δ Aquarii

[218] Frank & Meyerhof 1925, pp. 40-41; see also the corrections suggested by Kunitzsch 1959, p. 62, n. 1.

	Star Name	Identification
19	*Dhanab Qayṭus Shamālī*	ι Ceti
20	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are five plates serving the latitudes between 18° and 39;37°.

Table A009-2

	φ	Longest Day	(Locality)
1a	21;40°	13;18 hours	(Mecca)
1b	35	14;25	
2a	39;37	—	(Bukhara?)
2b	24	13;31	
3a	27	13;44	
3b	32	14;8	
4a	18	13;6	
4b	Double projection of 0° and 90°		
5a	Tablet of ecliptic coordinates		
5b	Tablet of horizons		

On all latitude faces (1a to 4a) altitude circles are drawn for every 6° and labelled on both sides; azimuth arcs are traced below the horizon for every 10° and labelled. Plain lines for seasonal hours and dotted lines for equal hours counted from the western and eastern horizons. Plates 4b, 5a and 5b are as in other astrolabes.

Geographical Gazetteer[219]

For engraving the gazetteer, the inner surface of the mater was divided into 4 annuli; eight diametricac lines divide these four rings to form 64 cells. However, many of the cells remain blank and the gazetteer is engraved, in a most eccentric manner, all over the astrolabe, on both sides of the *kursī*, on its rim, on the rim of the main body, on the back and so on. We reproduce the gazetteer below, according to the description by Frank & Meyerhof, but add serial numbers to the names of the cities. Of these, 27 cities are engraved on the inner side of the mater. But here, latitudes and longitudes are engraved only for four cities. It is highly intriguing why the gazetteer is incomplete on the inner surface of the mater and why it is engraved so inelegantly all over the astrolabe. The 66 localities engraved at different places on this astrolabe with or without their geographical coordinates are listed below.

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219 Frank & Meyerhof 1925, pp. 34-40.

Figure A009.3 – Geographical gazetteer (photo by S. R. Sarma)

Table A009-3 Geographical Gazetteer

	Place Name	L	φ
(On the front of the *kursī* immediately below the makers' inscription)			
01	Lahāwar	109;20	31;50
(On the back of the *kursī*)			
02	Makka	77;0	21;40
03	Madīnah	75;20	25;0
04	Bayt al-Maqdis	66;30	31;50

	Place Name	L	φ
(On the edges of the *kursī*)			
05	Kūfa	79;30	31;30
06	Baṣra	84;0	30;0
07	Baghdād	82;0	33;25
08	ᶜAdan	76;0	11;0
09	Jaddah	76;0	21;0
10	Yaman	77;0	15;30
(On the edge of the main body)			
11	Aḥmadābād	108;40	23;15
12	Kambāyat	109;20	22;20
13	Sawmnāt	106;0	17;0 !
14	Tānīsar	112;25	30;10
15	Pānīpat	113;10	28;52
16	Ajmīr	111;5	24;00
17	Akra	117;0	26;38
18	Dihlī	113;20	28;12
19	Kawālyar	115;0	26;29
20	Kannawj	112;50	26;36
21	Karra	107(?);6	26;36
22	Banāras	117;20	26;15
23	Badā’ūn	114;19	27;37
24	Baran	114;0	28;45
25	Jawnpūr	119;6	26;36
26	Awah	118;6	27;21

	Place Name	L	φ
27	Sannām	110;0(?)	30;30
28	Sambhal	115;15	28;20
29	Hānsī	112;25	29;15
30	Kol	114;19	28;0
31	Gopāmau	116;38	26;45
32	Lāhūr	109;20	31;50
33	Mūltān	107;35	29;40
34	Dawlatābād	102;0	20;30
(On the back, along the arc of the upper right quadrant)			
35	Aḥmadnakar	107;0	19;0
36	Rājkhar	109;15	18;20
37	Burhānpur	---	---
38	Ujjayn	112;0	22;30
(On the inner side of the mater itself, in the grid with three annuli, are engraved just the names of some towns, but without their longitudes and latitudes.)			
	Outer circle		
39	Amarkūt		
40	Sulṭānkūt		
41	Ilāhābād		
42	Hanzah	6770	1215[220]

[220] Common Arabic/Persian numerals were added later, representing the inḥirāf and maximum day length, as Frank and Meyerhof assume. They reproduce these values as 6775 and 1215 in the text and as 65° 55' and 12h 15 m in footnote 7. However, the astrolabe has 6770 and 1210, clearly distinguishing the zero from five.

	Place Name	L	φ
43	Sarangpur	6750	1440[221]
44	Sironj	6783	1450[222]
45	Narwar	6840	1520[223]
46	Kālinjar		
47	Shikarpūr ?		
48	Mungher		
49	Pandwā		
50	Sanārkāw		
51	Satkānw		
52	Khayrābād		
53	Sūrat		
54	Bījāpūr		
55	Kolkonda		
	Middle Circle		
56	Kābul		
57	Peshāwar		
58	Tabakpur		
59	Bandar		
60	Kalbarka		
61	Parenda		
62	Jawl (?)		

221 Frank & Meyerhof 1925 reproduce these wrongly as 6755 and 1140.

222 Not 1445 as Frank & Meyerhof 1925 write.

223 Frank & Meyerhof 1925 wrongly as 6845 and 1525.

	Place Name	L	φ
	Inner Circle		
63	Qandahār		
64	Harāt		
65	Mashhad		
66	Tahrān		

This gazetteer was not done by a single engraver, but by three as Frank and Meyerhof note. Nearly all the towns are from the Indian Subcontinent and that part of Afghanistan which was under Mughal rule. Remarkably enough there are very few towns from outside. These are engraved on the back and on the edges of the *kursī,* viz. Makka, Madīnah, Bayt al-Maqdis, Kūfa, Baṣra, Baghdād, ᶜAdan, Jadda and Yaman.

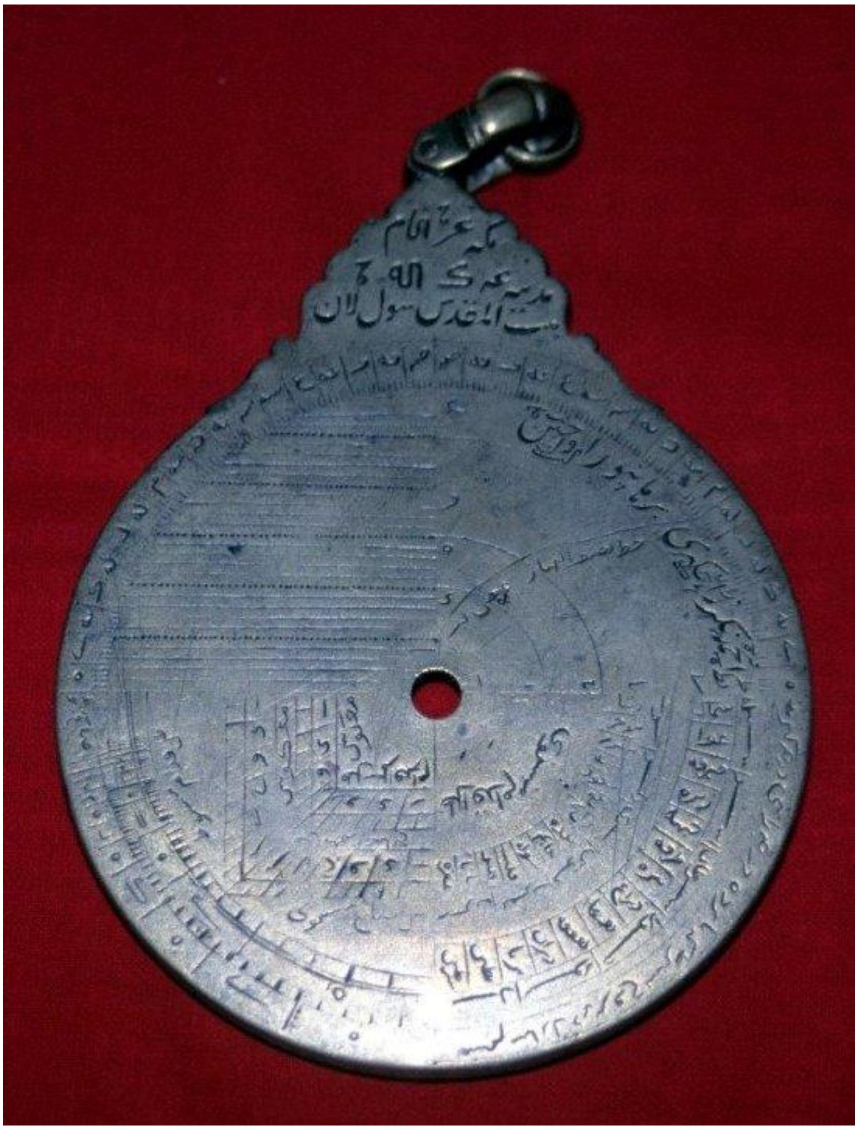

Figure A009.2 – Back of the astrolabe (photo by S. R. Sarma)

BACK

The rim of the two upper quadrants carries the altitude scales divided in 1° and 5° and labelled as 5—90; 90—5. The upper left contains a trigonometric quadrant with 30 horizontal parallels; each fifth is highlighted with dotted lines. The upper right quadrant is divided into 6 concentric zones to represent the six pairs of zodiac signs. Along the vertical and horizontal radii, the signs are labelled with their serial numbers. Superimposed on this grid is the graph for the midday solar altitude at the latitude 32°. This carries the label *khaṭṭ nisf al-nahār arḍ l-b,* 'line of midday, latitude 32°'.

In the lower left quadrant, two shadow squares are engraved one inside the other. That for 12 digits is outside. Under the horizontal scale is the label *zill aṣābī*^{c} *mustawī* (umbra recta in digits) and to the left of the vertical scale is the label *zill aṣābī*^{c} *ma*^{c}*kūs* (umbra versa in digits). The shadow square for 7 feet is inside. Within the square is the

label for the vertical scale *zill aqdām maᶜkūs* (umbra versa in feet). The label related to the horizontal scale is engraved in the lower right quadrant: *zill aqdām mustawī* (umbra recta in feet). The rim of the lower left quadrant carries the corresponding cotangent scales.

In the lower right quadrant are engraved the names of signs and the names of the corresponding lunar mansions in two batches.

Figure A009.3 – Inscription on the front of the *kursī* (photo by S. R. Sarma)

INSCRIPTION OF THE MAKERS[224]

On the front side of the kursī is engraved the following inscription in five lines:

sancat

tamat bāydī aḍcafī al-cibād

ibnī cīsā ibn allāhdād

sanah 1018 fī balad dār al-khilāfat

lāhāwar. ṣānah allāh tac can afāt al-dahwar.

‘Made by the two hands of the weakest of the servants [of God], the two sons of cĪsā, the son of Allāhdād, in the year 1018 in the city of Lahore, the abode of the Caliph. May the Great God save them from vicissitudes of fate.’

The year 1018 AH corresponds to AD 1609-10.

224 Frank & Meyerhof 1925, p. 34.

Conclusion

This astrolabe, though rather inelegantly produced, contains all the characteristic features of the Lahore astrolabes as they took shape in the oeuvre of ᶜĪsā. Can the two sons of ᶜĪsā ibn Allāhdād who produced this astrolabe be Qā’im Muḥammad and Muḥammad Muqīm? Qā’im’s surviving astrolabes and celestial globes are dated between 1032/1622 and 1046/1637. Muqīm’s extant astrolabes are dated between 1031/1621 and 1070/1659. If the two sons mentioned in the 1609 astrolabe are really Qā’im and Muqīm (and if the astrolabe is their early work), it is strange that there are no instruments by them from the period between 1609 and 1621. It is also possible that these two sons are not Qā’im and Muqīm but other sons who may not have produced any other instrument after this astrolabe. A third possibility is that the inscription was added later by somebody else.

Frank and Meyerhof are of the view that there are four different layers of engraving by different hands at different points of times. These layers are as follows: (1) The inscription on the front of the *kursī.* (2) The names of the 37 cities with their coordinates engraved on the edges of the astrolabe. (3) The names of the 27 cities engraved on the inner side of the mater. (4) The names of four cities with the *inḥirāf* and the maximum day length duration in common Arabic/Persian numerals engraved on the inner side of the mater. Therefore, it is not possible to determine whether the two sons of ᶜĪsā who produced this astrolabe in 1609 are indeed the accomplished instrument makers Qā’im Muḥammad and Muḥammad Muqīm.

Bibliography

Frank & Meyerhof 1925.

A010 ASTROLABE BY QĀ’IM MUḤAMMAD, AH 1034 (AD 1624-25)

Diameter ?

PLU

CCA 1128; Répertoire 2

Sulaiman Nadvi, who made the very first survey in 1935 of the astrolabes and globes made by the members of the Allāhdād family, states as follows: [225]

There is one astrolabe made by Qâ’im Muḥammad in Calcutta which belongs to Qâzi Obeidu’l Bârî.* It bears the following inscription.

> ᶜ*amal qā’im muḥammad ibn* ᶜ*īsā ibn allahdād aṣṭurlābī humāyūnī 1034 h[ijrī]*
>
> ‘The work of Qā’im Muḥammad, son of ᶜĪsā, son of Allahdād, the astrolabe maker of [Emperor] Humāyūni, 1034 Hijrī’.

On the other corner of this astrolabe is written the ‘21st year of Jahāngīr’s accession.’

The *Hijrī* year 1034 lasted from 13 October 1624 to 1 Oct 1625. About the owner of the astrolabe Qâzi Obeidu’l Bârî, Nadvi adds in a footnote: ‘He comes of an old family of Calcutta. I am indebted to Prof. Maḥfuzu’l Haqq of the Presidency College, Calcutta, for my information concerning this astrolabe.’

Since then, there has been no trace of this astrolabe.

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225 Nadvi 1935, p. 627.

A011⊙ ASTROLABE BY QĀ'IM MUḤAMMAD MADE FOR NAWĀB KHWĀJA ABŪ AL-ḤASAN, AH 1037 (AD 1627)

Diameter of the rete 326 mm

Patna, Khuda Bakhsh Oriental Public Library

Figure A011.1 – Full view of the rete (photo by S. R. Sarma)

Only the large rete with a unique calligraphic design survives of what must have been a yet larger and fabulous astrolabe. Among the one thousand and odd Islamic astrolabes that survive today in various museums throughout the world, there are occasional attempts to incorporate calligraphic designs into the *ᶜankabūt.* But nowhere so completely and so regally as in the present specimen. It is a pity that only a part is available and not the whole astrolabe.

Figure A011.2 – Portrait of Khwājah Abū al-Ḥasan, Musée Guimet, Paris[226]

226 The inscription below the portrait reads *shabīh khwājah abū’l ḥasan durust ikhlās-i camal hāshim* (True portait of Khwājā Abū al-Ḥasan painted sincerely by Hāshim).

The calligraphic design joining the star pointers states that the astrolabe was made in the reign of Jahāngīr for Nawāb Jumlah al-Mulkī Khwājah Abū al-Ḥasan. He held many important positions under Jahāngīr, such as the Subahdar of Deccan and the general paymaster of the household (*bakhshī-kul*).[227] *Jumlah al-Mulkī* is a title conferred on him.[228]

Figure A011.3 – Signature of the astrolabe maker on the reverse (photo by S. R. Sarma)

In the Lahore astrolabes, the maker’s signature is generally on the back of the mater. Here, luckily, it is engraved on the back of the rete, on the lower part of the ecliptic ring[229] and reads

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227 He is frequently mentioned in Jahāngīr’s Memoirs (see Jahangir, pp. 79, 80, 103, 172, 192, 202 appointed to Subahdar of Deccan, 219, 221, 256 made paymaster general, bakhshī-kul, 260, 282 promoted to a higher rank, 287, 318, 320).
There was another Abū al-Ḥasan who was related by marriage to both Jahāngīr and Shāh Jahān and was influential at the court of both the emperors. He was a brother of Nūr Jahān and thus brother-in-law of Emperor Jahāngīr; he was the father of Mumtāz Mahal and thus the father-in-law of the next emperor Shāh Jahān.
But in Jahāngīr’s Memoirs, the former is always referred to Khwājah Abū al-Ḥasan whereas the latter under the title Āsaf Khān. In my earlier publications (Sarma 1994d, Sarma 1999c, Sarma 2011a), I wrongly identified the Abū al-Ḥasan mentioned in the present astrolabe as Nūr Jahān’s brother.

228 In his mail of 28.11.2012, Professor Muzaffar Alam writes as follows:
‘I could not locate the title 'Jumlah al-Mulki' for Khwaja Abu al-Hasan. I checked first with Athar Ali Sahib’s “Apparatus”, and also two monographs, one on nobility under Jahangir (Afzal Husain), another nobility under Shahjahan (Firdaus Anwar). Athar Sahib does not even list him under Jahangir!
‘I understand that he is Khwaja Abu al-Hasan Turbati, an Iranian noble, who rose to become Mir Bakhshi under Jahangir, then appointed Diwan-i A'la after I'timad al-Daulah's death. He died in AH 1042 in Shahjahan’s reign. Majalis-i Jahnagiri mentions him as ‘Rukn al-Saltanat’ (also ‘Ma’asir al-Umara’), ‘Madar al-Muhamm’ and ‘Diwan-i Kull’. A noble with such high positions and titles could well be called ‘Jumlah al-Mulki’.’

229 He does so again in his astrolabe of 1635 (A013).

*ṣana*c*ahu aqall al-*c*ibād qā'im muḥammad ibn* c*īsā ibn allāhdād asturlābī lahūrī humāyūnī*

'The work of the least of the servants [of God], Qā'im Muḥammad, son of cĪsā, son of Allāhdād of Lahore, the astrolabe maker of [Emperor] Humāyūn.'

The rete consists of the two rings of the Tropic of Capricorn and of the ecliptic, both held together by the equinoctial bar which is counter-changed at the two intersections with the ecliptic ring. The space between the two rings and that inside the ecliptic ring is filled with calligraphic design.

In keeping with the exalted status of the patron, the rete was lavishly produced. On some segments the surface is decorated by plain lines. To the left and right of the ecliptic ring, in the spaces above the equinoctial bar, there are cut-outs in the shapes of flowers, with circular depressions, which may have been originally encrusted with gems.

Figure A011.4 – Right part of the rete (photo by S. R. Sarma)

Note the flower with five petals at the periphery. Gems may have been embedded in the depressions of the petals. The second arc from the right is the ecliptic. From the middle of the arc of the eclptic runs the term *Jahāngīrī* in florid letters.

The outer ring of the Tropic of Capricorn is plain with two concentric circles engraved on it. The sloping edge of the equinoctial ring is divided in units of 2° and these are numbered on the upper surface, separately for each sign from 2 to 30. The

names of the signs are cut out in silhouette along the inner edge of the ecliptic ring. In the lower half can be seen the names *Ḥamal, Thawr, Jawjā', Saraṭān, Asad* and *Sunbulah* and in the upper half the names *Mīzān, ᶜAqrab, Qaws, Jadī, Dalw* and *Ḥūt* proceeding in anti-clockwise direction.

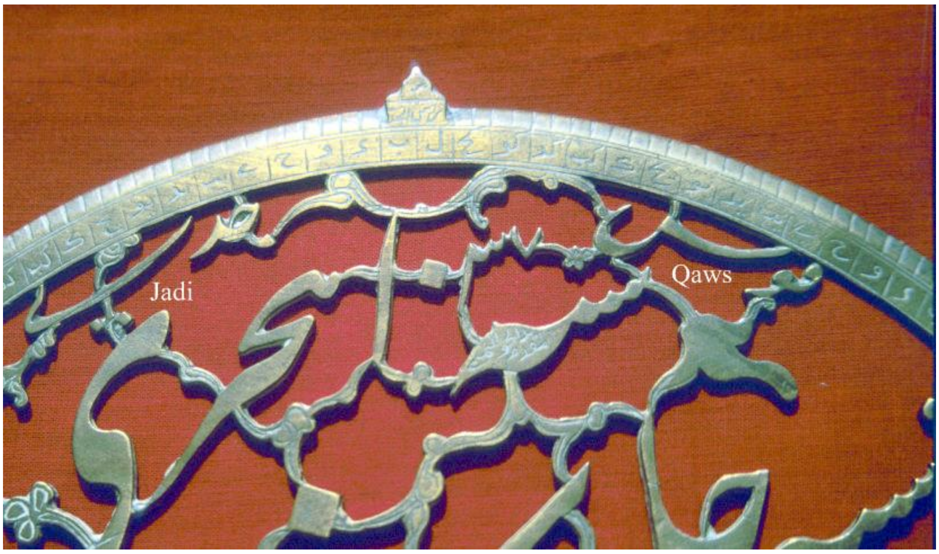

Figure A011.5 – Upper segment of the rete (photo by S. R. Sarma)

The arc above is that of the ecliptic. It is divided in 2° along the sloping edge, and numbered in 2s from 2 to 30, separately for each sign. The names of the signs are immediately below the ecliptic in cut out letters. On the right can be seen *Qaws* (Sagittarius) and on the left *Jadī* (Capricorn).

At the zero-point of Capricorn, there is a pointed projection on the ecliptic ring on which is inscribed *Rās al-jadī,* 'head of the Capricorn'. This point, generally known as *al-murī,* moves along the degree scale on the limb and indicates the position of the zodiac circle. There must have been a handle affixed to the equinoctial bar on its eastern segment between the Tropic of Capricorn and the Ecliptic. It is now lost, only a small hole remains where the handle must have been inserted.

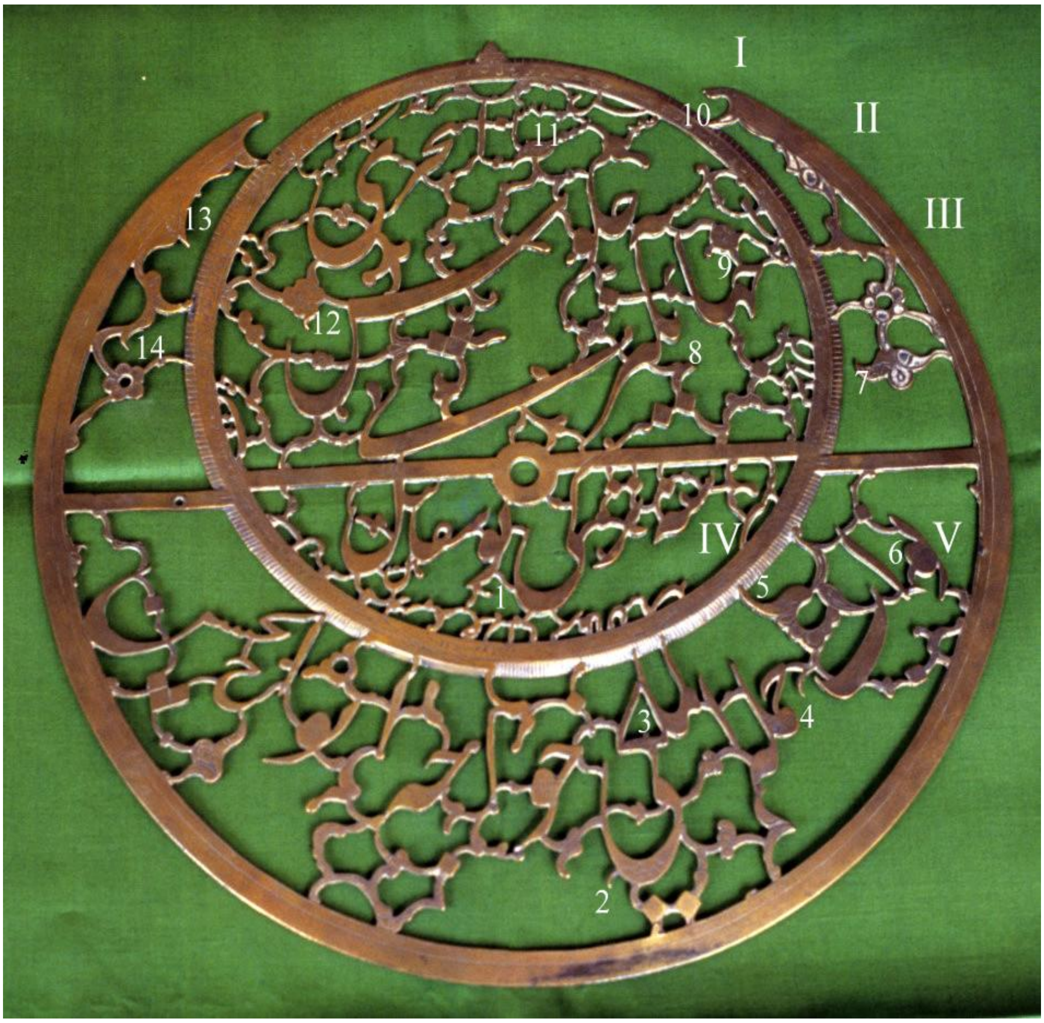

Figure A011.6 – The rete with the dedication and star pointers marked (photo by S. R. Sarma)

The calligraphic pattern joining the star pointers reads as follows in five lines:

I *sanah 1037 ḥijrī*

II *sanah julūs*

III *jahāngīrī 22*

IV *sanah turkī toshqān’īl*

V *nawāb jumlah al-mulkī khwājah abū al-ḥasan*

‘The year 1037 Hijrī / the regnal year of Jahāngīr 22 / in the Turkish year of the rabbit’[230] / Nawab Jumlah al-Mulkī Khwājah Abu al-Ḥasan.’

The year AH 1037 lasted from 11 September 1627 to 29 August 1628 (Gregorian). Jahāngīr died during in the course of this year on 8 November 1627. Therefore, the

230 Abū al-Faḍl 2, pp. 20-21: Turkish Era, the fourth year of the cycle is Tawishqān, the Hare.

astrolabe must have been completed between 11 September and 8 November 1627 shortly before Jahāngīr's death. There are 14 named star pointers in the rete which are listed below.

Table A011-1 Stars on the Rete

	Star Name	Identification
01	*Al-ᶜAyyūq*	α Aurigae
02	*Shiᶜrā Yamānī*	α Canis Majoris
03	*Shiᶜrā Shāmī*	α Canis Minoris
04	*Fard al-Shujāᶜ*	α Hydrae
05	*Qalb al-Asad*	α Leonis
06	*Qaᶜidat al-Bāṭiya*	α Crateris
07	*Simāk Aᶜzal*	α Virginis
08	*Simāk Rāmiḥ*	α Bootis
09	*Kiffa Shamālī*	β Librae
10	*Qalb al-ᶜAqrab*	α Scorpii
11	*Yad al-Ḥawwā al-Yumnā al-Muqaddam*	δ Ophiuchi
12	*Fam al-Faras*	ε Pegasi
13	*Dhanab al-jadī*	δ Capricorni
14	*Sāq Sākib al-Mā' al-Janūbī*	δ Aquarii

The rete is in good condition; in two cases, the star pointers appear to have come loose and are welded to the ecliptic ring.

BIBLIOGRAPHY

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Sarma 2011a

A012 ASTROLABE BY QĀ'IM MUḤAMMAD, AH 1041 (AD 1631-32)

1631, Lahore

Diameter 120 mm

Baghdad, Museum of Arab Antiquities (# 9721)

CCA 3821; Répertoire 5

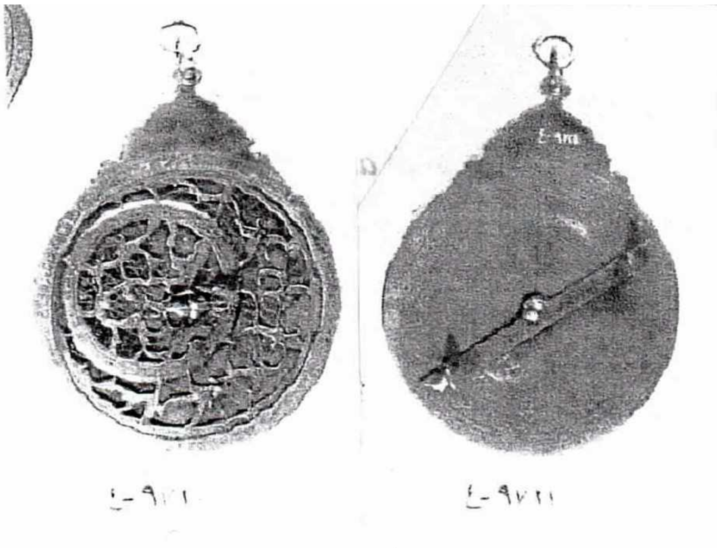

Figure A012.1 – Front and back of the astrolabe (photo from King 2005, p. 435)

The Répertoire mentions that the astrolabe carries the following inscription:

> *ṣana^{c}ahu aqall al-^{c}ibād qā'im muḥammad ibn ^{c}īsā ibn allāhdād asṭurlābī lāhūrī humāyūnī sanah 1041 hijrī julūs shāh jahān sanah 5*
>
> 'Made by the least servant [of God], Qā'im Muḥammad, son of ^{c}Īsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn. The year 1041 Hijrī, the 5th regnal year of [Emperor] Shāh Jahān.'

According to Répertoire, the astrolabe has 6 plates, a geographical gazetteer engraved on the inner side of the mater, a sine graph, a solar quadrant and astrological tables on the back.

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Faransīs & Naqshabandī 1957, pp. 28-32.

King 2005, pp. 434-435.

A013⊙ ASTROLABE BY QĀ’IM MUḤAMMAD, AH 1045 (AD 1635-36)[231]

Diameter 190.5 mm

Oxford, Museum of the History of Science (#42730)

CCA 71; Répertoire 6

Figure A013.1 – Front of the astrolabe (© Museum of the History of Science, Oxford)

[231] Gunther 1932, no. 71, pp. 191-197. Gunther misses the first part of the name and calls him merely as ‘Mohammad ibn Isa’. In the second edition of Gunther, the front view of this astrolabe adorns the back of the dust jacket.

Like the astrolabe of 1627 (A011), this too is an ambitious astrolabe with many new features. The rete contains a very large number of star pointers and, for the first time, two *zawraqī* or ship horizons. In the 7 plates, 5 plate faces carry double projections. On the latitude plates, in addition to the lines for seasonal and equal hours, there are also, for the first time, lines for the traditional Indian time units of *ghaṭīs* of 24 minutes. On several plates can be seen a circle for the visibility of the star *Suhayl* (Canopus). No other Lahore astrolabe carries this circle. There is also plate to be used with the *zawraqī* horizons. The back also contains many unusual elements, such as a series of completely circular scales including an eccentrically placed *Rūmī* or Syro-Macedonian calendar.

COMPONENTS

Body with *kursī* (d. 190.5, h. 265, t. 14), shackle and ring, rete (d. 169) for 58 stars, 7 plates (d. 169), alidade (l. 178) and pin. The original wedge is lost.

FRONT

The body, rim and *kursī* are made in one piece. The inner surface of the mater within the rim (where is the geographical gazetteer is engraved) is not perfectly flat, but slopes down from the rim towards the centre. Consequently, some of the plates became curved by the weight of the other plates above them. At the north point, a plug to hold the plates in position is inserted from the back and hammered flush with the surface of the back.

The ring is quite small for this massive astrolabe. It has a diamond cross-section with sharp edges; the shackle has a trifoliate shape with trifoliate bases, also with a diamond cross-section and sharply defined edges. The *kursī* is very high, the profiles consisting of a series of five ascending lobes with a trifoliate finial; with finely cut fretwork, the surface is filled with decorative lines.

The degree scale on the limb is divided into 0;30°, 1° and 5°, and numbered in 5s clockwise from 5° to 360°.

Figure A013.2 – Rete of the astrolabe (photo by S. R. Sarma)

RETE

The rete is thick in the middle and tapers towards the circumference, which facilitates the rotation of the rete around the central pin.

The two rings of Capricorn and the ecliptic are held together by the equinoctial bar, with one counter change, asymmetrically at its intersection with the ecliptic ring in the west. A small ring for the pin to pass through is incorporated into the equinoctial bar. Above this small ring, there are two parallel arcs, constituting the ‘ship’ (*zawraq*) horizons, which will be discussed below.

The space between the two rings of Capricorn and ecliptic and that inside the ecliptic ring is filled with floral tracery; decorative lines are engraved at some places on the tracery. Because of these decorative lines, it more difficult to read the star names than would have been otherwise.

There are about 58 named star pointers, mainly shaped like tiger’s claws. A partial, and somewhat faulty, list of these stars was published by Gunther;[232] Kunitzsch prepared a correct and more comprehensive list, but in the same sequence as given by Gunther.[233] In the following table, however, the stars are listed in the order of their increasing right ascension.

Table A013-1 Stars on the Rete

	Star Name	Identification
01	*Qarn al-Ḥamal*	γ or β Arietis
02	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
03	*Baṭn al-Ḥūt*	β Andromedae
04	*Fam al-Qayṭus*	γ Ceti
05	*Ṣadr al-Qayṭus*	π Ceti
06	*Rās al-Ghūl*	β Persei
07	*Mirfaq al-Thurayyā*	α Persei
08	*Masāfat al-Nahr*	γ Eridani
09	*ᶜAyn al-Thawr*	α Tauri
10	*ᶜAyyūq*	α Aurigae
11	*Rijl al-Jawzā’ al-Yusrā*	β Orionis
12	*Yad al-Jawzā’ Yusrā*	γ Orionis
13	*Yad al-Jawzā Yumnā*	α Orionis
14	*Rijl al-jawzā’ al-Yumnā*	κ Orionis
15	*Shiᶜrā Yamānī*	α Canis Majoris
16	*Shiᶜrā Shāmī*	α Canis Minoris

232 Gunther 1932, I, p. 192.

233 Kunitzsch 1959, pp. 62-64.

	Star Name	Identification
17	*Ṭarafat al-Safīna*	ρ Puppis
18	*Suhayl*[234]	α Carinae
19	*Minkhar Shujā^c*	σ Hydrae
20	*Qafẓah al-Ūlā*	ν Ursae Majoris[235]
21	*Thāniya*	μ Ursae Majoris[236]
22	*Fard al-Shujā^c*	α Hydrae
23	*Thālith*	ι Ursae Majoris[237]
24	*Nathra Saḥābī*	ε Cancri
25	*Qalb al-Asad*	α Leonis
26	*Ẓahr al-Dubb al-Akbar*	α Ursae Majoris
27	*Qā^{c}idat al-Bāṭiya*	α Crateris
28	*Ẓahr al-Asad*	δ Leonis
29	*Al-Ṣarfa*	β Leonis
30	*^{c}Anāq*	ζ Ursae Majoris[238]
31	*Janāḥ al-Ghurāb*	γ Corvi
32	*Simāk A^{c}zal*	α Virginis
33	*Simāk Rāmiḥ*	α Bootis
34	*Kiffa Janūbī*	α Librae
35	*Kiffa Shamālī*	β Librae

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234 The star *Suhayl* is no. 56 in in the list of Kunitzsch 1959, p. 64. But I cannot locate it on the rete at all!

235 Savage-Smith 1985, p. 136: *al-qafzah al-ūlā,* 'the first leap,' νξ UMa.

236 Savage-Smith 1985, p. 136: *al-qafzah al-thāniyah,* the second leap, λμ UMa.

237 Savage-Smith 1985, p. 136: *al-qafzah al-thālithah,* 'the third leap,' ικ UMa

238 Kunitzsch 1959 has γ Andromedae which is clearly a misprint.

	Star Name	Identification
36	*Nayyir al-Fakka*	α Coronae Borealis
37	*ᶜUnuq al-Ḥayya*	α Serpentis
38	*Qalb al-ᶜAqrab*	α Scorpii
39	*Rukbat al-Ḥawwā' Yusrā*	ζ Ophiuchi
40	*Rās al-Jāthī*	α Herculis
41	*Rās al-Ḥawwā'*	α Ophiuchi
42	*Yad al-Ḥawwā' Yumnā*	ν Ophiuchi[239]
43	*Nasr Wāqiᶜ*	α Lyrae
44	*ᶜIṣābat al-Rāmiḥ*	ρ or υ Sagittarii
45	*Minqār al-Dajāja*	β Cygni
46	*Nasr Ṭā'ir*	α Aquilae
47	*Dhanab al-Dulfīn*	ε Delphini
48	*Dhanab al-Dajāja*	α Cygni
49	*Fam al-Faras*	ε Pegasi
50	*Janāḥ al-Faras*	γ Pegasi
51	*Dhanab al-Jadī*	δ Capricorni
52	*Mankib Sākib al-Mā'*	α Aquarii
53	*Sāq Sākib al-Mā' J[anūbī]*	δ Aquarii
54	*Dhanab al-Qayṭus S[hamālī]*	ι Ceti
55	*Mankib al-Faras*	β Pegasi
56	*Matn al-Faras*	α Pegasi

[239] Kunitzsch 1959 remarks that the instrument maker may have actually meant δ Oph which he ought to have labelled as … *yusrā*.

	Star Name	Identification
57	*Surrat al-Faras*	δ Pegasi
58	?	

Zawraqī horizons on the rete

The most notable feature of the rete are the two parallel arcs placed above the small ring at the centre. These look like the outlines of boats, their upright masts represented by the corresponding segments of the vertical meridian. Therefore, this projection is called *zawraq* (ship). The *zawraqī* astrolabe was invented by al-Bīrūnī’s contemporary Abu Saᶜīd Sijzī.

Astrolabes with this design may have been made and used at the time of its invention in the eleventh century and later, but no such astrolabes are extant today. All that exists now are a few Lahore astrolabes in which one or two *zawraqī* horizons are incorporated in the otherwise standard retes and which contain a special plate to be used along with the *zawraqī* horizons. The present astrolabe is the earliest specimen known to us.

Here the upper arc is fashioned like the ecliptic circle in the rete. It is divided into the first six signs of the zodiac and is labelled with their names from right to left. On the sloping edge, each sign is divided into five units. The function of this arc is not known. The lower arc carries the legends *ufq mujassam gharbī* (the horizon of the western solid) and *ufq mujassam sharqī* (the horizon of the eastern solid).[240] Obviously this arc is the proper *zawraqī* horizon, but the latitude is not mentioned. It is probably 42°. This horizon has to be used together with a special type of projection engraved on plate 7b which will be described below. In this plate, inside a miniature plate, a horizon is drawn for latitude 42°.

PLATES

There are seven plates with the following specifications:

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[240] Rendered thus in Gunther 1932, p. 192.

Table A013-2 Plates

	φ	Longest day
1a	27°	13;4 hours
1b	32°	14;8 hours
2a	25°	13 hours
2b	30° + 36°	
3a	35°	15;27 hours
3b	22° + 40°	
4a	38°	14;38 hours
4b	18° + 44°	
5a	23;30°	13 hours
5b	20° + 70°	
6a	0° + 90°	
6b	Tablet of horizons	
7a	Tablet of ecliptic coordinates	
7b	Tablet to be used with the *zawraqī* horizons	

Six plate faces carry the projections for six different terrestrial latitudes from 23;30° to 38°. In particular, plate 1 carries projections for 27° and 32° on its two sides for the two Mughal imperial cities of Agra and Lahore. This became a standard feature in all the astrolabes by Muḥammad Muqīm and Ḍiyā’ al-Dīn Muḥammad. The tablet of horizons is engraved on 6a and the tablet of ecliptic coordinates on 7a. Usually these are engraved on the two sides of the same plate in the Lahore astrolabes, in particular in the astrolabes made by Muḥammad Muqīm and his nephew Ḍiyā’ al-Dīn Muḥammad.

On the six plate faces for the latitudes 23;30°, 25°, 27°, 32°, 35° and 38°, altitude circles are drawn for every 2° and every fifth line is highlighted by dots; azimuths arcs are drawn for every 30° above the horizon and for every 6° below the horizon. In the lower half, plain lines are drawn for seasonal hours and dotted lines for equal hours

which are counted from the western horizon. All the four types of lines are numbered in *abjad.*

On plates 32°, 35°, 38° lines for *ghaṭīs* (of 24 minutes) are drawn from the western horizon and numbered in standard Arabic/Persian numerals from 1 to 35 or 36. This is a useful innovation because the *ghaṭī* was the traditional unit of time in India and was used for practical purposes for both Hindus and Muslims alike.[241] It would have been better if the *ghaṭī* lines were drawn also on the plate for 27° (Agra). Latitude 38° falls far north of the Indian subcontinent where the time unit of the *ghaṭī* was never used.

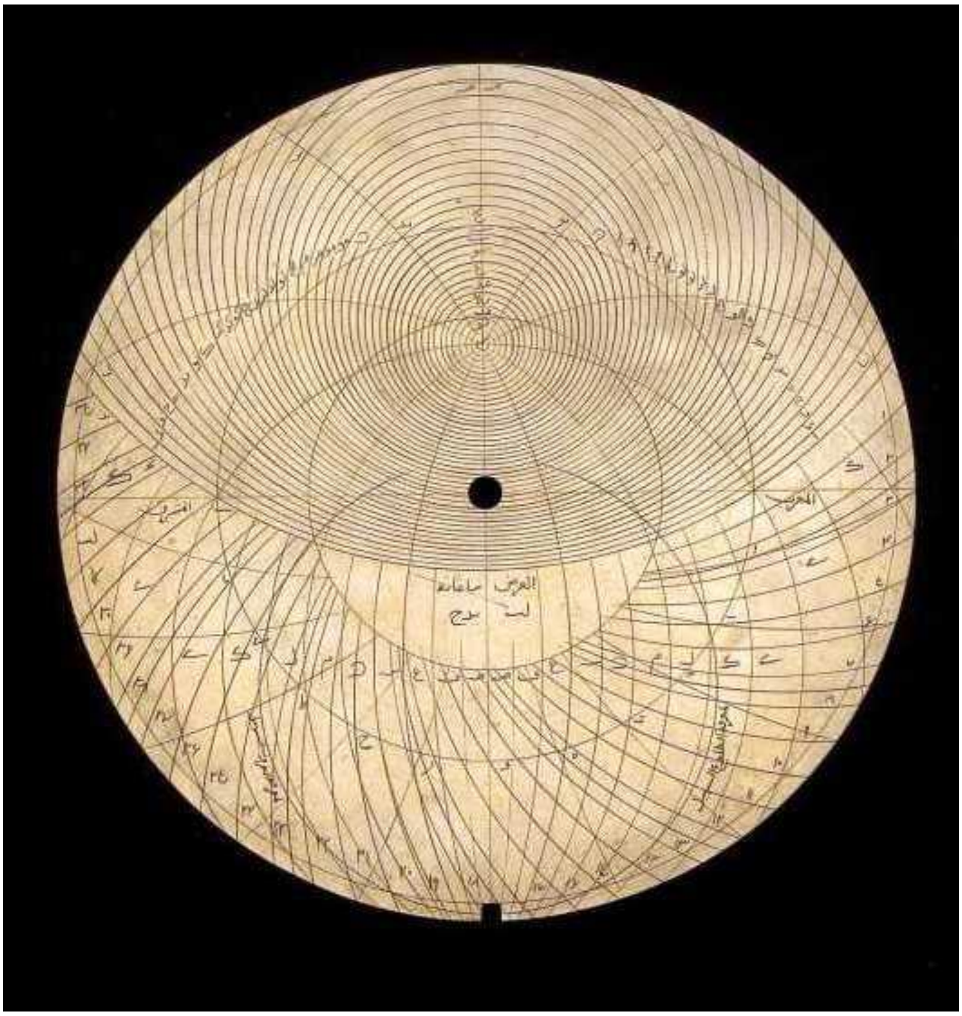

Figure A013.3 – Plate for Latitude 32°; notice the circle of the 'Visibility of Canopus' in the lower half (© Museum of the History of Science, Oxford)

241 On the use of the time unit, see the section R on water clocks.

Circle of the Visibility of Canopus

Furthermore, on as many as 9 plate faces (viz., 1a, 1b, 2a, 2b, 3a, 4a, 4b, 5a, 7b) a dotted circle is drawn most of which occupies the lower half. No other Lahore astrolabe carries this circle.

Figure A013.4 – Labels on plate for 27° (photo by S. R. Sarma)

Following legends are engraved along the western and eastern sides respectively: *l'maʿrifat al-ṭalūʿ al-suhayl* (for the knowledge of the rising of Canopus) and *l'maʿrifat al-gharūb al-suhayl* (for the knowledge of the setting of Canopus).

Figure A013.5 – Label on plate for 32° east (photo by S. R. Sarma)

North-South Projections on the plate for 23;30°

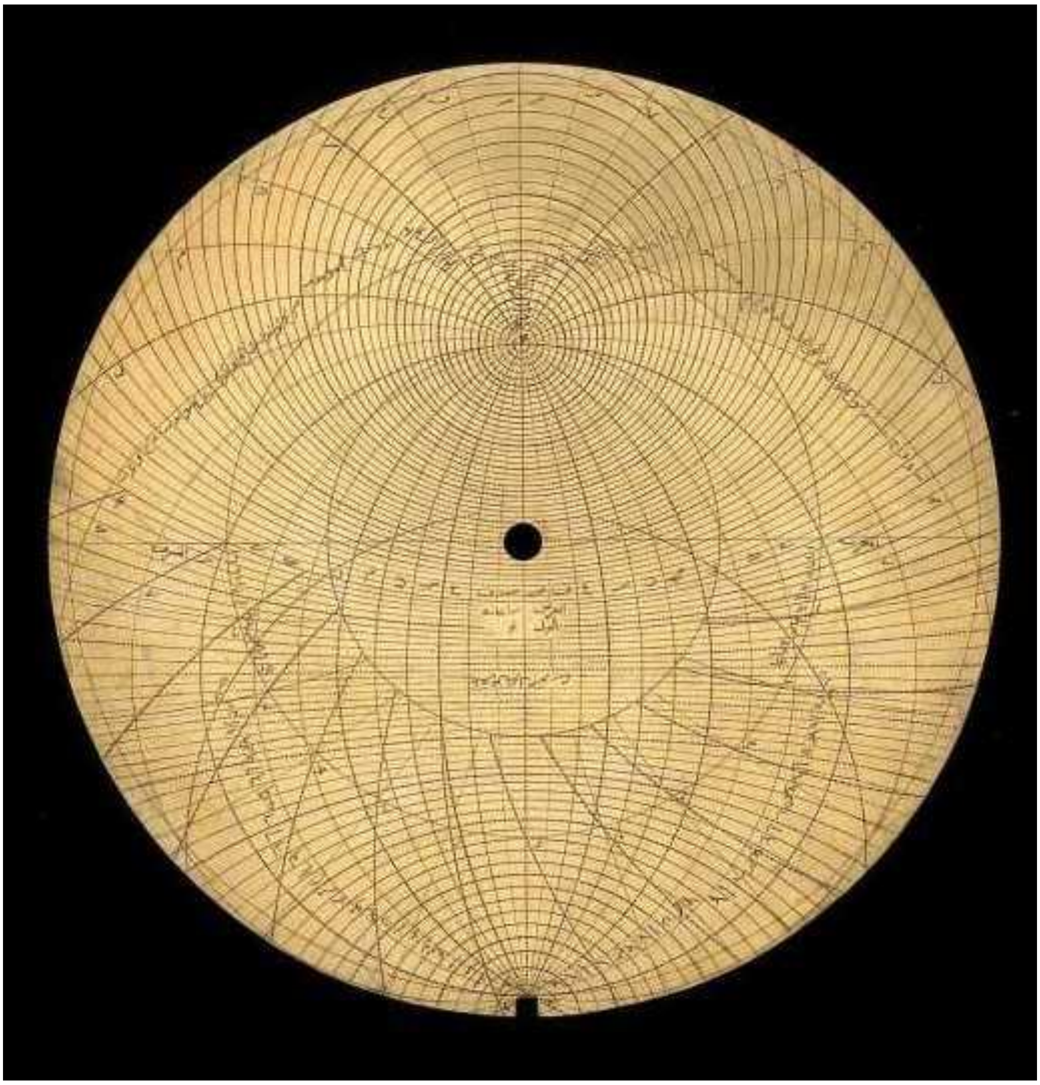

Figure A013.6 – Plate for 23;30° (© Museum of the History of Science, Oxford)

Plate 4a carries the projections for 23;30°. This is the traditional value of the latitude of Ujjain which is considered to be situated on the Tropic of Cancer. On this plate altitude circles are drawn for every 2°, azimuth arcs for every 6° above and below the horizon. There are lines for seasonal hours and dotted lines for equal hours counted from the western horizon, but no lines for *ghaṭīs.*

Interestingly in the lower half are drawn altitude circles for the southern projection. There is a label stating *ᶜarḍ 23;30 janūbī* (latitude 23;30 south).

Most unusual is, however, that as many as five plate faces (viz., 2b, 3b, 4b, 5b, 6a) carry double projections. The double projection for the latitudes 0° and 90° occurs in other astrolabes also, but the rest are rare. These plates serve mainly didactic purposes,

but show the great skill of the astrolabe maker in drawing highly complicated projections.

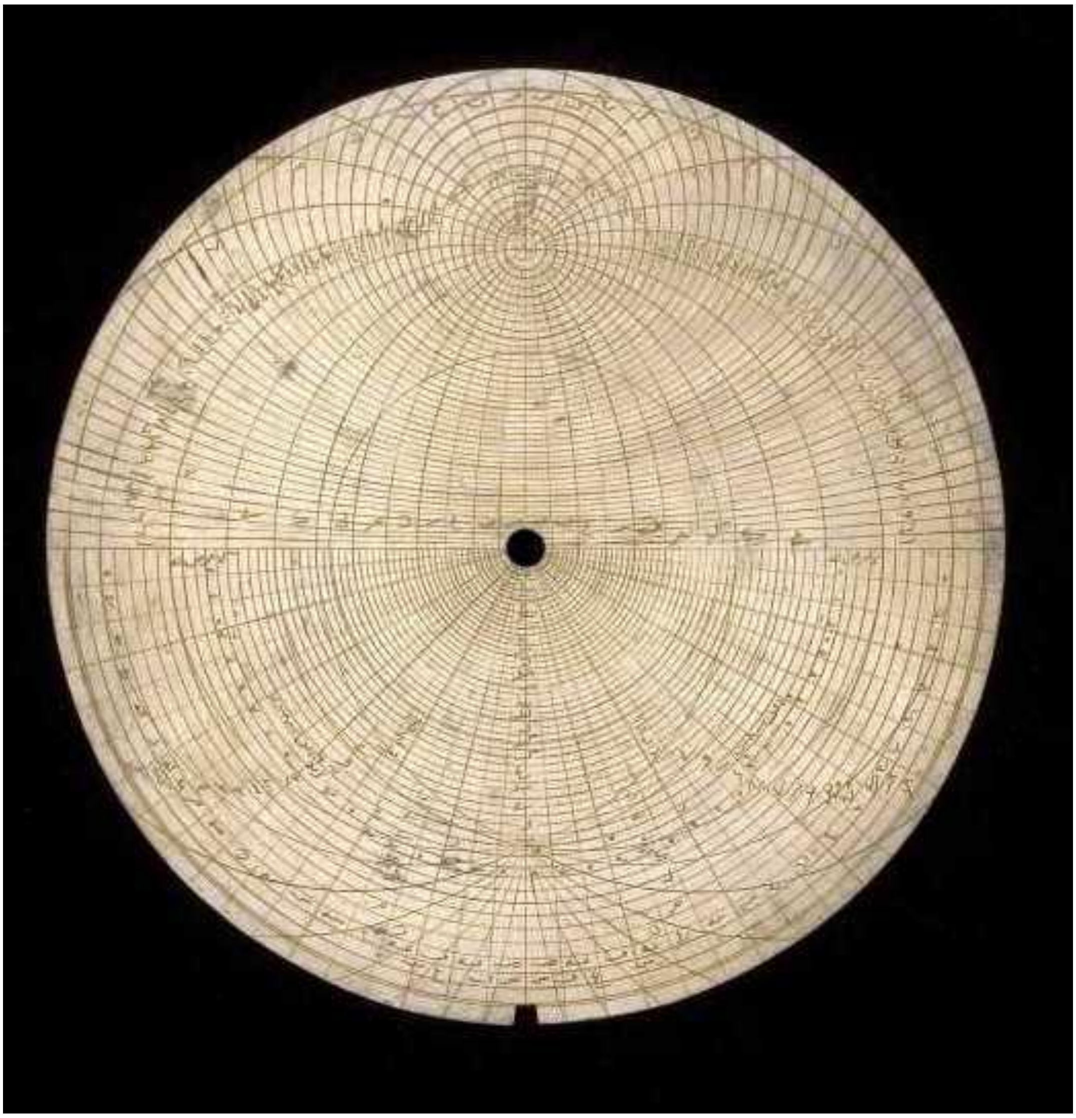

Figure A013.7 – Double Projection for the Latitudes 0° and 90
(© Museum of the History of Science, Oxford)

6a Tablet of horizons

On the tablet of horizons, half horizons are drawn in four batches at intervals of 6° in the following manner:

6	12	18	…	78	84	90
7	13	19	…	79	85	90
8	14	20	…	80	86	90
4	10	16	…	82	88	90

Strangely latitudes 3, 9, 15 … 81, 87, 90 are omitted. There are declination scales marked 6, 12, 18 and 23;30, the last value being that of the obliquity. There is no label on the plate.

7a. Tablet of Ecliptic Coordinates

It is similar to that found in the previous astrolabes. It carries the label *mīzān al-ᶜankabūt.*

7b. Tablet to be used with the *Zawraqī* Horizons

This plate is specially designed for use in conjunction with the *zawraqī* horizons incorporated in the rete. Like the other plates, this one is also engraved with the vertical and horizontal diameters, and the three concentric circles of the Tropic of Capricorn, the celestial equator and the Tropic of Cancer. Under the horizontal diameter or the east-west bar is engraved *al-maghrib* and *al-mashriq* on the west and east respectively.

Two mutually intersecting oblique horizons are drawn across the plate. The arc with the convex side to the north is the oblique horizon for the latitude 32° and that with the convex side to the south is the horizon of the latitude 27°. Where the arcs intersect with the equinoctial colure, there are labels at the end of each horizon. Thus at the two ends of the horizon for 27° are engraved *ufq sharqī ᶜarḍ 27* on the east, meaning ‘eastern horizon latitude 27’ and *ufq gharbī ᶜarḍ 27* on the west, meaning ‘western horizon latitude 27’. Likewise, at the two ends of the horizon for 32° is engraved *ufq ᶜarḍ 32* both times.

Figure A013.8 – Plate to be used with *zawraqī* horizons
(© Museum of the History of Science, Oxford)

The twelve astrological houses are marked, once outside the equator and once inside the circle of Cancer, but with a difference. Outside the equator the division of the houses commences from the west point and proceeds counterclockwise, but inside the Cancer circle the division commences a little below the east-west line and proceeds counterclockwise. The names of the astrological houses are engraved in elongated letters so that the names occupy the full stretches of the corresponding houses. In Arabic, the first house is named *al-ṭāliᶜ*, 'the ascendant,' and the rest are called by the ordinal numbers: 1. *al-ṭāliᶜ*, 2. *al-thānī*, 3. *al-thālith*, 4. *al-rābiᶜ*, 5. *al-khāmis*, 6. *al-sādis*, 7. *al-sābiᶜ*, 8. *al-thāmin*, 9. *al-tāsiᶜ*, 10. *al-ᶜāshir*, 11. *al-ḥādī ᶜashar*, 12. *al-thānī ᶜashar*.

Each house, as marked outside the equator, is divided in 5 parts, and numbered as 6, 12, 18, 24, 30 in counter-clockwise direction. Arcs emanating from the centre of the plate (?) pass through these divisions.

Inside the circle of Cancer, there is a ring which is divided into the 12 astrological houses; these commence a little below the east-west line. These houses are divided into 10 parts each, but numbered in 6s as before with 6, 12, 18, 24, 30 in the counter-clockwise direction inside the equatorial circle. Arcs emanating from the centre of the plate (?) pass through these divisions of 10 parts. Thus, outside the circle of Cancer, these families of arcs produce a mesh.

Inside the ring of the astrological houses marked within the circle of Cancer is the miniature projection for the latitude 42° drawn upside down.[242] Here are two concentric rings (as they would be on the rim of an ordinary plate); the inner one is divided in 2° and the outer one in 6° and labelled in 6s from 6° to 360° starting at the south point of the miniature plate. The numbers proceed clockwise and because the space is extremely limited the hundreds' signs often omitted. There are the concentric circles of the equator and the Tropic of Cancer. The oblique horizon is marked by a dotted line, above which are drawn altitude circles for every 6° and numbered on both sides of the meridian. Azimuth arcs are drawn both above and below the horizon for every 30°. Lines for seasonal hours and dotted lines for equal hours counted from the western horizon are drawn. In the space between the oblique horizon and the circle of Cancer is inscribed *al-ᶜarḍ 42* (latitude 42 [degrees]) to the west of the meridian and *sāᶜāt 15* (longest day 15 [hours]) to the east of the meridian. Finally, the ecliptic circle is drawn touching the circle of Cancer in south and the circle of Capricorn in the north. This circle is divided into the 12 zodiac signs and labelled with their names. The names commence from the east point on the east west bar and proceed counter-clockwise. Each sign is further subdivided into 5 units.

The plate also carries, on the eastern part, a complete dotted 'circle of the visibility of Canopus' placed symmetrically on either side of the east-west line. Above the upper part is the inscription *l'maᶜrifat al-gharūb al-suhayl* (for the knowledge of the setting of

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242 It is not clear why the latitude 42° was chosen here.

Canopus) and below the lower part *l’ma^{c}rifat al-ṭalū^{c} al-suhayl* (for the knowledge of the rising of Canopus).

At the bottom of the plate is a long inscription bearing the designation of this special plate: *ṣafīhat maṭraḥ al-shu^{c}ā^{c} kahtrd* (?) *abī rayhān taswīyat al-buyūt khwānand,* (plate for finding the projection of the astrological rays according to (?) Abū Rayhān [al-Bīrūnī] [and] equalization of the astrological houses).[243]

Geographical Gazetteer

On the inner side of the mater is engraved a geographical gazetteer in three concentric circles. The gazetteer is read counter-clockwise from the upper vertical radius. The first cell in each row is filled with the argument: *al-bilād, al-ṭūs, al-^{c}arḍ.* The localities are arranged according to climates. But astrolabe maker commences with the second climate because he wishes to begin the gazetteer with the holy cities of Medina and Mecca which are situated in this climate. After a certain number of cities, the climate to which these belong is engraved across the three rows.[244]

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243 Gunther 1932, p. 194, describes it thus: ‘a complicated plate in the centre of which is a miniature tablet for lat. 42°, hours 15. Across the bottom is written “A table of the projection of rays”, which according to Albiruni is also called “equalization of houses” (=areola, Nallino, p. 324).’

244 Two years later, in 1637, his brother Muḥammad Muqīm arranged the gazetteer according to climates in a more elegant manner (A024); cf. Abbasi & Sarma (forthcoming). See also A014.

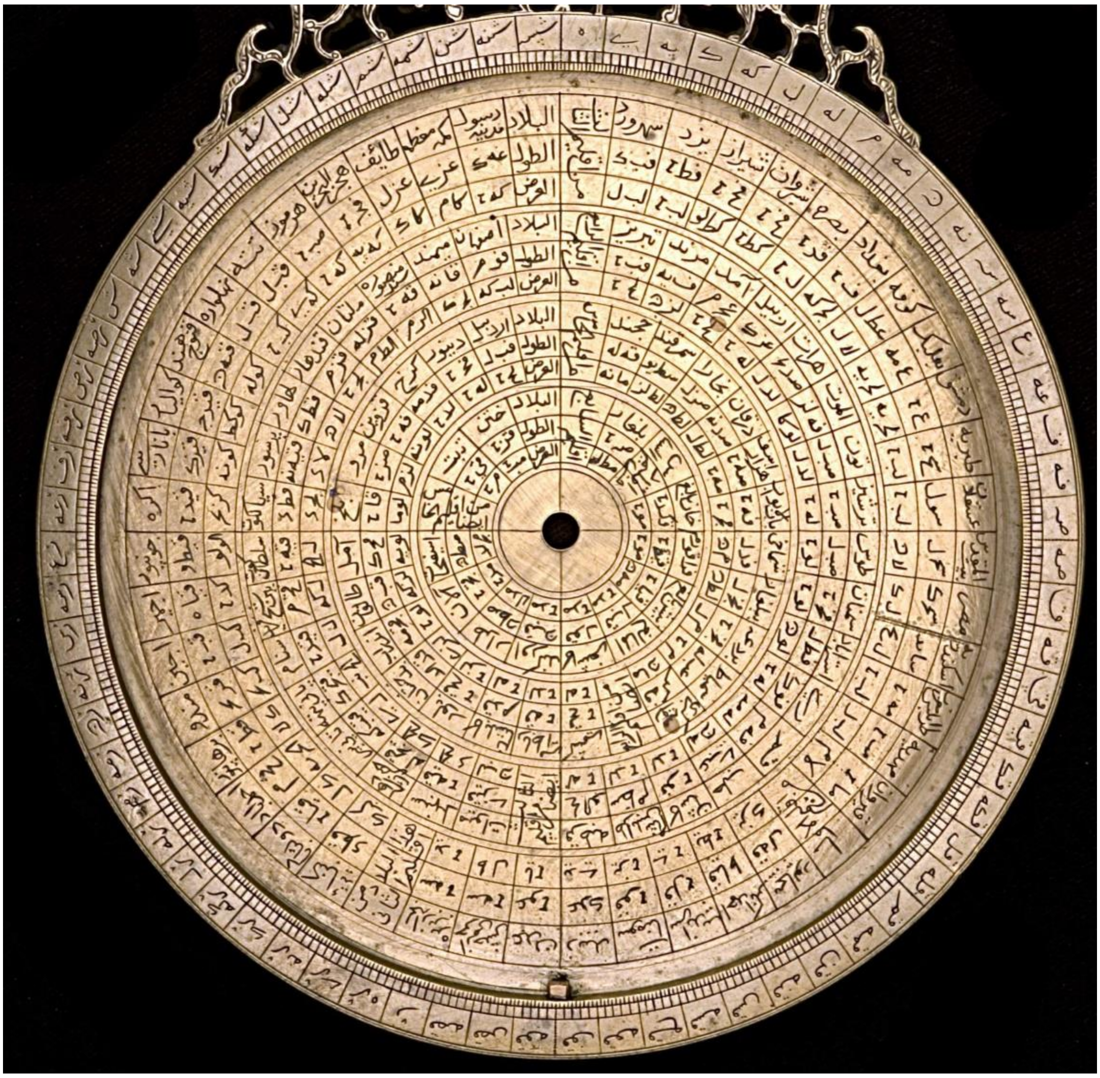

Figure A013.9 – Geographical gazetteer (© Museum of the History of Science, Oxford)

Table A013-3 Geographical Gazetteer

	Place Name (*al-bilād*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)
	First Circle		
1	Madinat Rasūl	75;20	25;0
2	Makka Mubārak	77;10	21;40
3	Ṭāᶜif	77;30	21;20
4	Hajar al-Baḥrayn	83;0	25;15
5	Hurmūz	92;0	25;0
6	Tatta	102;30	25;10

	Place Name (*al-bilād*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)
7	Nahlawāra	102;30	22;0
8	Qannawj Hind	115;50	26;35
9	Kawāliyar	114;3	27;13
10	Bānārasī	114;0	26;36
11	Akra	114;0	27;13
12	Jawnpūr	119;6	26;36
13	Ajmīr	112;5	24;0
14	Ujjayn	112;0	22;30
15	Mandu	107;13	22;13
16	Burhānpūr	109;0	20;21
17	Aḥmadābād	108;40	23;15
18	Dawlatābād	111;0	20;30
19	Kanbāyat	109;4	22;20
haḍ al-bilād min iqlīm al-thānī (these [are] cities of the second climate)			
20	Bajja az Barbar	65;0	14;0
21	Jarmī az Habasha	65;0	9;30
22	Adan	76;0	11;0
23	Dabīl	74;20	14;10
24	Sawmnāt	107;0	17;0
25	Sarandīb	130;0	10;0
26	Aḥmadānakar	112;9	19;0
27	Bījāpūr	105;30!	17;20
min iqlīm al-awwal (of the first climate)			
28	Qīrwān	41;0	31;40

	Place Name (*al-bilād*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)
29	Mahdiyya	42;0	32;30
30	Ṭarābulus Maghrib	45;0	32;0
31	Iskandariyya	61;14	30;18
32	Miṣr	63;20	30;20
33	Bayt al-Maqdis	63;30	31;50
34	ᶜAsqalān	66;30	32;0
35	Ṭībariya	68;0	32;0
36	Dimashq	70;0	33;15
37	Baᶜalbak	70;45	33;15
38	Kūfa	79;30	31;30
39	Baghdād	80;0	33;25
40	Baṣra	84;0	30;0
41	Shabzwān	88;0	29;0
42	Shīrāz	88;0	29;36
43	Yazd	89;0	32;0
44	Suhraward	82;20	32;30
min iqlīm al-thālith (of the third climate)			
	Second Circle		
45	Iṣfahān	86;40	32;25
46	Mīmand	101;55	33;20
47	Sind Mansūra	105;0	27;40
48	Mūltān	107;35	29;40
49	Qandahār	107;40	33;0
50	Lahāwar	109;20	31;50

	Place Name (***al-bilād***)	**L** (***al-ṭūl***)	**φ** (***al-ᶜarḍ***)
51	Parsūr	115;55	31;20
52	Siyālkot	109;4	33;4
53	Sulṭānkot	115;0	30;28
54	Pīnshaḥ Farīd?	118;40	30;25
55	Sanām	114;0	30;30
56	Pānīpaht	113;20	28;52
57	Tānīsīr	112;25	30;10
58	Ḥaẓrat Dehlī	113;35	28;30!
59	Sanbhal	115;0	28;4
60	Mewāt	117;10	32;50
ayḍān min iqlīm al-thālith (also of the third climate)[245]			
61	Qurṭaba	18;26	35;0
62	Ṭarabulus Shām	69;40	34;0
63	Kāshān	86;0	34;0
64	Ḥalab	72;10	35;50
65	Qūm	85;40	35;45
66	Rayy	86;20	35;0
67	Astarābād	89;30	36;50
68	Samnān	83;0	36;0
69	Ṭūs	92;30	36;0
70	Turshīz	92;0	35;0
71	Tūn	92;30	34;30

245 There is no need of this label here; its purpose is served by the label at the end of the second circle.

	Place Name (*al-bilād*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)
72	Alamūt	85;37	36;21
73	Herāt	94;13	34;30
74	Arbīl	77;20	35;0
75	Āmad	73;40	38;0
76	Marand	80;15	37;50
77	Tabrīz	82;0	38;0
min iqlīm al-thālith (of the third climate)			
	Third Circle		
78	Ardabīl	82;30	38;0
79	Dinawar	83;0	35;0
80	Karkh	84;45	34;0
81	Qazwīn	85;0	36;55
82	Marw	97;0	37;40
83	Balkh	101;0	36;41
84	Āmul	88;20	36;15
85	Ṭāliqān	102;50	37;25
86	Andarāb	103;45	36;0
87	Badakhshān	104;24	37;10
88	Balūr	108;0	37;0
89	Kābulistān	104;40	35;0
90	Ribāt Amīr	105;0	34;0
91	Kashmīr	108;0	35;00
min iqlīm al-rābiᶜ ayḍān (also of the fourth climate)			
92	Rūmiyya Kabrī	85;27	41;50

	Place Name (*al-bilād*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)
93	Samyāṭ	72;35	40;0
94	Bardaᶜa	83;0	40;30
95	Babulghār	83;30	39;50
96	Shamākhī	84;30	40;50
97	Bāb al-Abwāb	85;0	43;0
98	Hazār Asf	95;0	45;0[246]
99	Darqān	94;55	39;30
100	Bukhārā	97;30	39;50
101	Samarqand	69;16!	39;37
102	Khujand	105;35	41;55
min iqlīm al-khāmis (of the fifth climate)			
	Fourth Circle		
103	Khutan	107;0	42;0
104	Tubbat	110;0	40;0
min iqlīm al-khāmis ayḍān (also of the fifth climate)			
105	Isfījāt	99;50	43;34
106	Ālān	103;0	44;0
107	Ṭarāz	99;50	44;0
108	Awazqand	102;50	44;0
109	Kāshghar	106;30	44;0
110	Al-Māligh	102;30	44;0
111	Bīshān Bāligh	111;0	45;50

246 This latitude belongs actually to the sixth climate and not here!

	Place Name (*al-bilād*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)
112	Qarāqūram	119;0	46;0
113	Khān Bāligh	124;0	46;0
min iqlīm al-sādis (of the sixth climate)			
114	Bulghār	90;0	49;3?
iqlīm al-sābiᶜ (the seventh climate)			

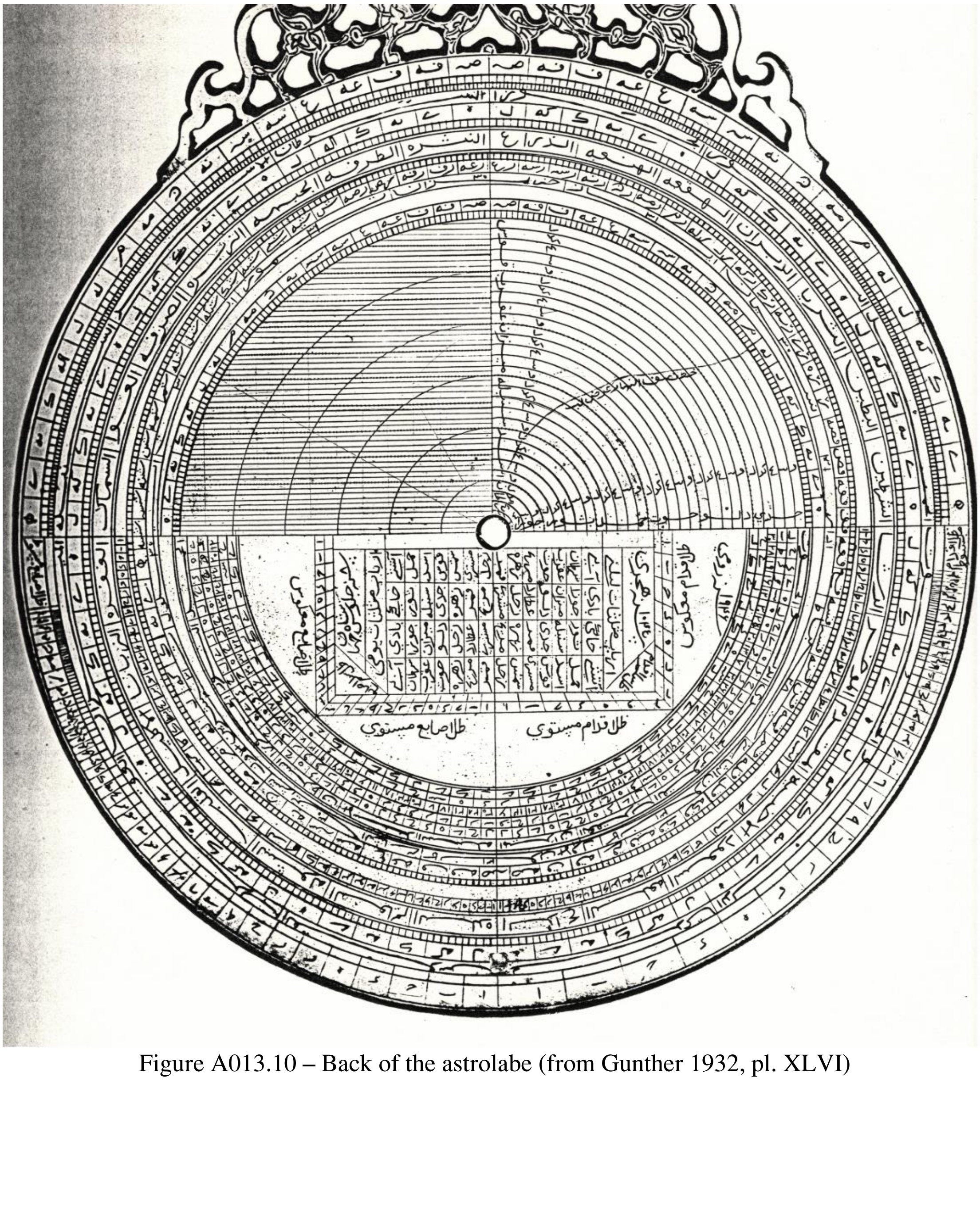

Figure A013.10 – Back of the astrolabe (from Gunther 1932, pl. XLVI)

BACK

On the back, the rim of the two upper quadrants carries a degree scale divided as in the front, but numbered as 5—90;90—5 for measuring the altitudes. The rim of the lower half has the two scales of cotangents for feet and digits in two rows. Inside these circular scales, there are eight concentric rings bearing the following scales:

1. Names of the zodiac signs starting from the west point and proceeding clockwise;
2. 1/6 parts of the signs numbered in *abjad* as 5, 10, 15 … 30 separately for each sign;
3. Single degrees of arc;
4. Names of the 28 lunar mansions starting from the west point and proceeding clockwise;
5. A scale engraved only in the lower half, with *abjad* numbers as 1, ... 22, 23;30, 30;23, 22 … 1 separately in each quadrant;

6-7-8. Then follows in the three rows a calendar of *Rūmī* (Syro-Macedonian or Byzantine) solar months which is placed eccentrically.[247] Blank spaces are left on either side of these eccentric rings for adjusting the space with the concentric rings.

Ring 6 is divided in single degrees. In ring 7, groups of 5° are labelled in *abjad* from 5 to 360. The counting commences at 2 degrees below the horizontal diameter (= 2° Libra). Finally, in row 8 are the names of the *Rūmī* months above which are written the number of civil days in the standard Arabic numerals:

1. *Tishrīn al-Awwal 31* (October)
2. *Tishrīn al-Thānī 30* (November)
3. *Kānūn al-Awwal 31* (December)
4. *Kānūn al-Thānī 31* (January),
5. *Shubāṭ 28* (February)
6. *Ādhār 31* (March)
7. *Nīsān 30* (April)
8. *Ayyar 31* (May)
9. *Ḥuzayrān 30* (June)
10. *Tammūz 31* (July)

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247 On calendar scales on the back, cf. Morrison 2007, pp. 111-114.

11. *Āb 31* (August)
12. *Aylūl 30* (September)

Then in the upper half, the altitude scales are repeated once more in 1° and 5° and numbered 5—90; 90—5 as on the rim.

Trigonometric Quadrant in the Upper left

In the upper left is the sexagesimal trigonometric quadrant with 60 horizontal parallels (to indicate cosines of every 1/60 part of the Radius); each fifth line is highlighted with dots. Attempts are made also to draw 12 vertical parallels but these are not completely engraved. Three radial lines are drawn at intervals of 30°. The declination arcs for each 30° of solar longitude drawn in the upper right quadrant are extended into this quadrant as well, which is somewhat unusual.

Solar Quadrant in the Upper Right

In the upper right quadrant, declination circles are drawn for every 6° of solar longitude, with every fifth circle being highlighted with dots. The names of the corresponding signs are engraved along the two radii. Starting at the centre along the vertical axis the names of *Saraṭān* (Cancer) to *Qaws* (Sagittarius) (i.e., from summer solstice to winter solstice) and starting from the periphery along the horizontal radius the names of *Jadī* (Capricorn) to *Thawr* (Taurus) (i.e., from winter solstice to summer solstice). The one-fifth part of each sign is numbered in lines somewhat deviating from the radii as 6, 12, 18, 24, 20 separately for each sign. Here was drawn a graph for the meridian altitude of the sun throughout the year with the label *khaṭṭ niṣf al-nahār bi ᶜarḍ 32* (line of midday at latitude 32°).

Shadow Squares

In the lower half are engraved two shadow squares, on the left for the gnomon of 12 digits and on the right for the gnomon of 7 feet. The vertical and horizontal scales are appropriately divided and numbered. In the corner on the left is the label *ẓill sallum aṣābiᶜ* (shadow scale in digits) and in the corner on the right *ẓill sallum aqdām* (shadow scale in feet). The four scales bear the following labels:

vertical scale on the left: *ẓill aṣābiᶜ maᶜkūs* (umbra versa in digits),
horizontal scale on the left: *ẓill aṣābiᶜ mustawī* (umbra recta in digits),

horizontal scale on the right: *ẓill aqdām mustawī* (umbra recta in feet),
vertical scale on the right: *ẓill aqdām mustawī* (umbra versa in feet).

Tables of Trigons

Inside the shadow squares are the following two tables on the left and on the right respectively.

Table A013-4 Regents of the Trigons in the Daytime

Regents of the Trigons in the Daytime (*arbāb muthalthāt yawmī*)			
Fiery *ātishī*	Earthy *khākī*	Airy *bādī*	Watery *ābī*
Aries	Taurus	Gemini	Cancer
Leo	Virgo	Libra	Scorpio
Sagittarius	Capricorn	Aquarius	Pisces
Sun	Venus	Saturn	Venus
Jupiter	Moon	Mercury	Mars
Saturn	Mars	Jupiter	Moon

Table A013-5 Regents of the Trigons at Night

Regents of the Trigons at Night (*arbāb muthalthāt laylī*)			
Fiery *ātishī*	Earthy *khākī*	Airy *bādī*	Watery *ābī*
Aries	Taurus	Gemini	Cancer
Leo	Virgo	Libra	Scorpio
Sagittarius	Capricorn	Aquarius	Pisces
Jupiter	Moon	Mercury	Mars
Sun	Venus	Saturn	Venus
Saturn	Mars	Jupiter	Moon

Semicircular scales in the lower half

Around the shadow squares are six semi-circular rows. The first three rows constitute the table of limits (*al-ḥudūd*) with names of signs in the first row, the names of the planets (alphabetic symbols) in the second row and the limits (in *abjad*) in the third row.

Table of the Limits

Table A013-6 Limits of the Signs

Aries	Jupiter 6	Venus 6	Mercury 8	Mars 5	Saturn 5
Taurus	Venus 8	Mercury 6	Jupiter 8	Saturn 5	Mars3
Gemini	Mercury 6	Jupiter 6	Venus 5	Mercury 7	Saturn 6
Cancer	Mars 7	Venus 6	Mercury 6	Jupiter 7	Saturn 4
Leo	Jupiter 6	Venus 5	Saturn 7	Mercury 6	Mars 6
Virgo	Mercury 7	Venus 10	Jupiter 4	Mars 7	Saturn 2
Libra	Saturn 6	Mercury 8	Jupiter 7	Venus 7	Mars 2
Scorpio	Mars 7	Venus 4	Mercury 8	Jupiter 5	Saturn 6
Sagittarius	Jupiter 12	Venus 5	Mercury 5	Saturn 4	Mars 4
Capricorn	Mercury 7	Jupiter 7	Venus 8	Saturn 4	Mars 4
Aquarius	Mercury 6	Venus 6	Jupiter 7	Mars 5	Saturn 5
Pisces	Venus 12	Jupiter 4	Mercury 2	Mars 9	Saturn 2

The fourth row contains another table related to the signs, but the exact significance of the 5 columns of numbers is not understood.

Table A013-7

Aries	15	20	24	24	30
Taurus	8	12	22	27	30
Gemini	6	12	17	22	30
Cancer	7	13	19	26	30
Leo	6	11	18	22	30
Virgo	7	17	21	27	30

Libra	6	12	21	20	30
Scorpio	7	11	16	22	30
Sagittarius	12	17	22	26	30
Capricorn	7	12	22	27	30
Aquarius	7	13	20	2-	30
Pisces	12?	?	?	27	30

The sixth and seventh rows show the regents of the faces or decans.

Table A013-8 Faces of the Signs

	10°	**20°**	**30°**
Aries	Mars	Sun	Venus
Taurus	Mercury	Moon	Saturn
Gemini	Jupiter	Mars	Sun
Cancer	Venus	Mercury	moon
Leo	Saturn	Jupiter	Mars
Virgo	Sun	Venus	Mercury
Libra	Moon	Saturn	Jupiter
Scorpio	Mars	Sun	Venus
Sagittarius	Mercury	Moon	Saturn
Capricorn	Jupiter	Mars	Sun
Aquarius	Venus	Mercury	Moon
Pisces	Saturn	Jupiter	Mars

Figure A013.11 – Alidade of the astrolabe (photo by S. R. Sarma)

ALIDADE ETC

The straight bar astrolabe has ornate ends and an ornate centre-piece. The left half of the alidade carries declination scales corresponding to the arcs of the signs in the upper right quadrant. On the edge, each sign is divided into parts. On the surface, starting from the centre, the names of the corresponding pairs of signs are engraved thus: *Saraṭān – Jawjā'* (Cancer – Gemini); *Asad – Thawr* (Leo – Taurus); *Sunbula - Ḥamal* (Virgo – Aries); *Mīzān – Ḥūt* (Libra – Pisces); *ʿAqrab – Dalw* (Scorpio – Aquarius); *Qaws – Jadī* (Sagittarius – Capricorn).

The edge of the right half is divided into 60 units to match the divisions of the trigonometric quadrant. On the surface groups of 5 units are labelled, starting from the centre, as 5, 10, 15… 60.

In the lower register on the right is a scale of unequal hours, to be used when the alidade is employed as a sundial, with the sighting plate on the right functioning as the gnomon.

The rectangular sighting plates have two holes each.

Figure A013.12 – Signature of the astrolabe maker (photo by S. R. Sarma)

Inscriptions

On the back of the rete of this astrolabe, as in the astrolabe of 1627 (A011), the maker’s signature is engraved on the lower half of the ecliptic ring:

> *ṣanaᶜt aqall al-ᶜibād qā’im muḥammad ibn ᶜīsā ibn allāhdād asṭurlābī lāhūrī humāyūnī.*
>
> ‘The work of the least of the servants [of God], Qā’im Muḥammad, son of ᶜĪsā, son of Allāhdād of Lahore, the astrolabe maker of [the Emperor] Humāyūn.’

The year of production of the astrolabe is engraved in three eras on the back of the astrolabe to the left and right of the shadow squares; *sanah 8 julūs shāhjahān* on the left margin of the shadow squares, *sanah 1045*[248] *hijrī* on the right margin of the shadow squares and *sanah 1946 rūmī* further to the right just below the semi-circular scales.

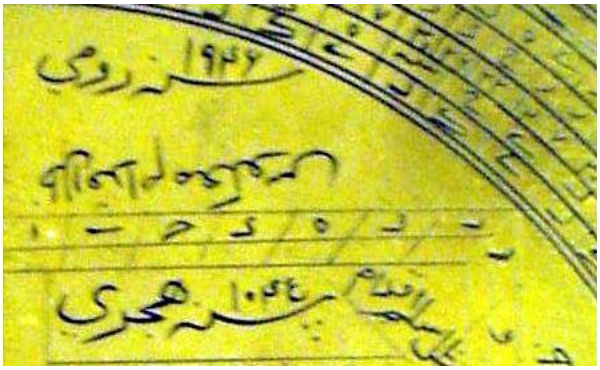

Figure A013.13 – Dates engraved to the right of the shadow squares (photo by S. R. Sarma)

The *Hijrī* year 1045 runs from 16 June 1635 to 3 June 1636 and the *Rūmī* (Syro-Macedonian) year is 1946 from 11 October 1934 to 10 October 1635. Since Shāh Jahān’s coronation took place on 14 February 1628, his eighth regnal year would be roughly from February 1635 to January 1636. Therefore, the astrolabe was completed sometime during 16 June 1635 and 10 October 1635.

Bibliography

Gunther 1932, no. 71, pp. 191-197, plates XLV-XLVI, figs. 94-97.

Kunitzsch 1959, pp. 62-64.

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[248] The common Arabic/Persian numerical symbol used for 5 is somewhat unusual (it looks like the Arabic letter *ᶜayn* ع), but it occurs also in the *ghaṭī* scales, and is clearly different from the symbol of 4. Nevertheless, Gunther 1932, p. 191, reads the *Hijrī* year as ‘1044’ and assigns the astrolabe to AD 1634.

A014⊙ ASTROLABE ATTRIBUTABLE TO QĀ'IM MUḤAMMAD, AH 1031 (AD 1621-22)

Diameter 169 mm

London, Nasser D. Khalili Collection of Islamic Art (#SCI 12)

Figure A014.1 – Front of the astrolabe (photo by S. R. Sarma)

This unsigned astrolabe with the richly decorated *kursī* has some features in common with Qā’im Muḥammad’s astrolabe of 1045/1635-36 (A013) which has been described just above. As in A013, here also lines for *ghaṭīs* of 24 minutes are drawn on many plates; what is new here is that on many plates the maximum duration of daylight is expressed in *ghaṭīs*.[249] Also in common with A013 is the arrangement of the gazetteer; it is organized according to climates, but commences with the second climate so that the holy cities of Medina and Mecca occupy the first two places. Though unsigned, it carries the year AH 1031 on the front of the *kursī* and Jahāngīr’s regnal year 17 on the back of the *kursī*. The mention of Jahāngīr’s regnal year also favours the ascription of this astrolabe to Qā’im Muḥammad, for this is done also in astrolabe A011. The present astrolabe then is the earliest extant astrolabe by Qā’im Muḥammad.

COMPONENTS

Body with *kursī* (d. 169, h. 218, t. 8.5), shackle and ring, 5 plates, alidade and pin. The rete and the wedge are replacements.

Figure A014.2 – The front and back of the *kursī* (photo by S. R. Sarma)

FRONT

The ring is very small with a diamond cross-section. The shackle is trifoliate. The *kursī* is not pierced but embellished with calligraphy in relief. The profiles are made up of ogees at the base and at the top with two lobes in between. The finial is trifoliate. A pair of raised decorative lines run along the entire rim of the *kursī* and also of the finial creating a kind of groove in which red gems were embedded, some of which are now

[249] Lines for *ghaṭīs* are drawn and the maximum duration of the daylight is stated in *ghaṭīs* in several astrolabes made by Qā’im Muḥammad’s son Ḍiyā’ al-Dīn and in the large zoomorphic astrolabe at Jaipur (A051) which is attributable to Qā’im’s younger brother Muḥammad Muqīm.

missing. There are inscriptions in *nasta^{c}līq* style and in high relief on both sides of the *kursī.* The inscription on the front reads *allāh-u akabar sanah 1031 hijrī* and the inscription on the back *sanah 17 julūs jahāngīrī.* The inscriptions are surrounded by leaf and flower designs.

The Hijrī year 1031 runs from 15 November 1621 to 3 November 1622 and Jahangir's seventeenth regnal year from ca. 10 March 1622 to 9 March 1623. Therefore, the astrolabe was completed between 10 March and 3 November 1622.

The limb is divided in 5°, 1° and 0;30° and numbered in 5s clockwise from 5 to 360.

Rete

The rete is clearly not original, but a crude replacement where the edges of the fretwork are not even properly smoothened. It consists of a very broad Capricorn ring and still broader ecliptic ring. Both are joined rather clumsily by the equinoctial bar which has two counter changes at the equinoxes. The equinoctial colure does not always lie on the edges of the bar, but runs sometimes in the middle of the bar and sometimes even outside the bar. The solstitial bar is shown in the lower half between the two rings. A crude tracery joins the star pointers some of which are named and others not. The ecliptic is divided in zodiac signs and labelled with their names; each sign is divided in 5 parts on the sloping edge of the ecliptic ring but these parts are not numbered. To the left of the north point is a handle to turn the rete around the centre. There are faint traces of star names on some of the pointers; *Simāk A^{c}zal* (α Virgionis), *Qalb al-^{c}Aqrab* (α Scorpii) and *Rās al-Ḥawwā'* (α Ophiuchi) can be discerned.

Figure A014.3 – Rete of the Astrolabe (photo by S. R. Sarma)

PLATES

There are five plates; the first four serve latitudes between 19° and 40°. On some these plates, altitude circles are drawn for each 2° and numbered as 2, 6, 10, … 90; on other plates for each 3° and numbered 3, 6, 9, …90. Azimuth arcs are traced for each 9° below the horizon. Most interesting are the hour lines. Plain lines are drawn, as usual, for seasonal hours, but these are numbered from 1 to 12 in standard Arabic/Persian numerals. On many plates (1a, b; 2a, b; 3b, 4a) dotted lines are drawn for *ghaṭīs* of 24 minutes from the western horizon and numbered from 1 to 32. The maximum duration of the daylight or the longest day is expressed in hours on some plates and in *ghaṭīs* on some other plates, as shown in the table below. Here *ghaṭīs* are called *karīhā,* where *karī* stands for *ghaṭī* and -*hā* indicates plural. But the values are not very accurate in either case.

Table A014-1 Plates

	φ	Longest Day in hours	in *ghaṭīs*
1a	19°		32
1b	20;41°		32!
2a	32°		35
2b	35°		35!
3a	36°	14	
3b	40°		38
4a	27°		34
4b	22° +	13;22	
30°	13;18		
5a	Tablet ecliptic coordinates		
5b	Tablet of horizons		

Plate 4b displays a composite projection for the latitudes 22° and 30°. The choice of latitude 20;41 on plate 1b is inexplicable. It is probably an error for 21;40 which is the latitude of Mecca. The fifth plate carries the tablet of ecliptic coordinates on the obverse and the tablet of horizons on the reverse.

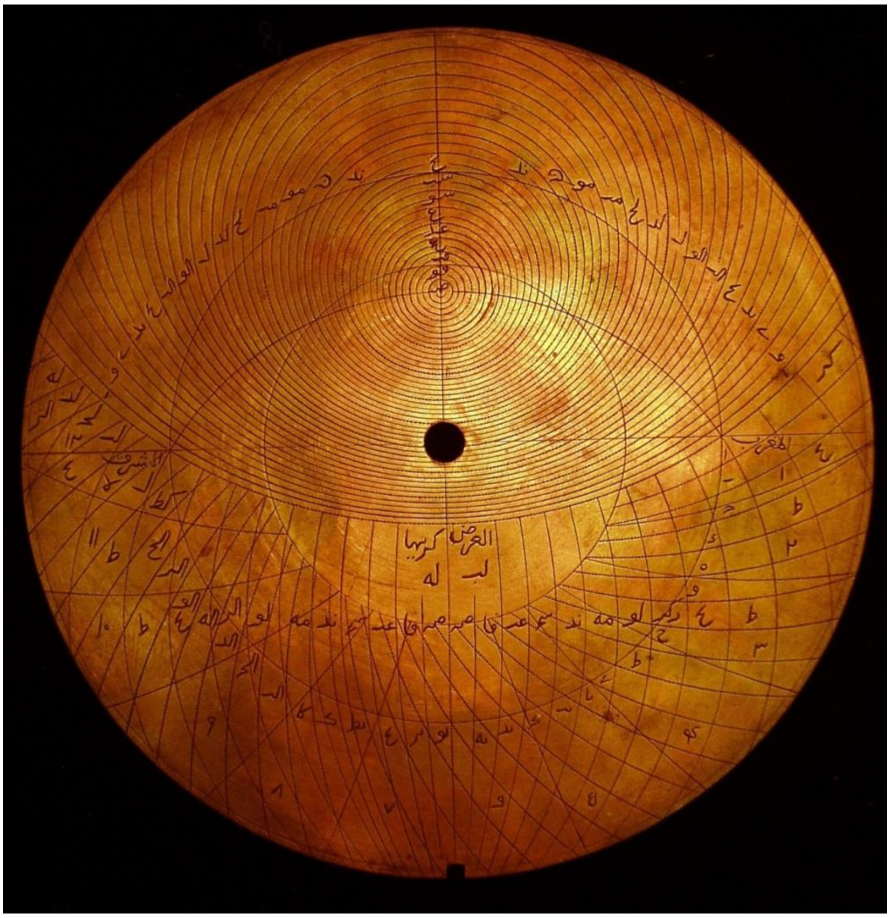

Figure A014.4 – Plate for the latitude of 32° (photo by S. R. Sarma)
Note the dotted *ghaṭī* lines numbered from 1 to32 and the daylight hours designated as *karīhā 35*.

GEOGRAPHICAL GAZETTEER

The geographical gazetteer provides the names, longitudes and latitudes of 69 places in three circles. The places are arranged according to climates which are mentioned in the headings engraved upside down in the rows between the circles. The enumeration commences in the first circle with the second climate (*iqlīm al-thānī*) so that the gazetteer begins with the names of the two holy cities of Medina and Mecca. After providing the coordinates of 16 places belonging to the second climate, five cities of the first climate are mentioned, followed by fourteen places of the third climate. Thereafter, in the second and third circles, climates are mentioned sequentially up to the seventh climate.[250]

[250] Maddison & Savage-Smith 1997, p. 223, state that 'the mater is engraved as a gazetteer of the longitudes and latitudes of 69 places, arranged according to three of the seven "climes" (the third, fourth and fifth)'. In fact, all the seven climates are represented here.

Figure A014.5 – Geographical Gazetteer (photo by S. R. Sarma)

Indian cities are mentioned in the second and first climates in the first circle. Here Kannauj (no. 5) is referred to as *Dār Mulk Hind* (capital of India)[251], Ahmedabad (15) is

[251] An attribute apparently derived from Ulugh Beg’s geographical table; Sédillot 1853, p. 270.

given the suffix 'Gujarat' while Daulatabad (16), Bijapur (20) and Ahmadnagar (21) receive the epithet 'Dakkhin' (Deccan, lit. south). No other astrolabe gazetteer shows these peculiarities.

Strangely the coordinates in many entries conclude with 4 minutes. It appears that the engraver carelessly engraved the *abjad* sign for 4 in the place of the usual symbol for zero which too is used in many places.

Table A014-2 Geographical Gazetteer

	Place name	L	φ
	First circle		
hazā al-bilād min iqlīm al-thānī (these cities belong to the Second Climate)			
01	Madīnat Rasūl	75;20	25;0
02	Makka Mubārak	77;10	21;40
03	Hurmūz	92;0	25;0
04	Tatta	102;7	25;10
05	Qannawj **Dār Mulk Hind**	115;50	26;36
06	Banārasī	117;20	26;55
07	Jawnbūr	119;6	26;36
08	Akra	114;0	27;4
09	Ajmīr	111;5	25;0
10	Kawāliyar	115;0	26;29
11	Ujjayn	102;0	22;30
12	Mandu	107;4	22;6
13	Burhānbū[r]	109;0	20;31
14	Kanbayāt	109;3	22;20
15	Ahmadābād **Kujarāt**	108;40	23;15

	Place name	L	φ
16	Dawlatābād **Dakkhin**	111;0	20;30
hazā al-bilād min iqlīm awwal (these cities belong to the First Climate)			
17	Jarmī Dār Mulk Habasha	65;0	9;30
18	ᶜAdan	76;0	12;0
19	Sanaᶜā' dār Mulk Yaman	77;0	14;30
20	Bījābūr **Dakkhin**	105;30	17;20
21	Aḥmadnakar **Dakkhin**	111;9	19;0
hazā al-bilād min iqlīm al-thālith (these cities belong to the Third Climate)			
22	Qayrawān	41;0	31;40
23	Miṣr	63;20	30;20
24	Bayt al-Maqdis	66;30	31;50
25	Kūfa	79;30	31;30
26	Baghdād	80;30	33;25
27	Shīrāz	88;0	29;36
28	Yazd	89;0	32;30
29	Iṣfahān	86;0	32;35
30	Multān	107;35	29;40
31	Qandahār	107;40	33;0
32	Lāhūr	119;20	31;50
33	Siyālkūt	109;0	33;0
34	Dihlī	114;48	28;43

	Place name	L	φ
35	Sunām[252]	114;25	30;30
	Second Circle		
ayḍā min iqlīm al-thālith (also belong to the Third Climate)			
36	Bānībatah	113;20	28;52
37	Tānīsar	112;25	30;10
38	Panbahal ?	115;0	28;4
39	Qila Rājkarī	109;15	33;20
hazā al-bilād min iqlīm al-rābiᶜ (these cities belong to the Fourth Climate)			
40	Ḥalab	72;10	35;50
41	Marāgha	82;0	37;4
42	Tabrīz	82;0	38;0
43	Karkh	84;45	34;0
44	Qarwīn	85;0	36;55
45	Kāshān	86;0	34;0
46	Qumm	85;45	35;45
47	Rayy	86;20	35;0
48	Tāliqān	85;45	36;10
49	Ṭūs	92;30	36;0
50	Tūn	92;30	34;30
51	Harāt	94;4	34;30
52	Balkh	101;0	36;41
53	Badakhshān	104;24	37;10

252 Spelt wrongly as Supnām

	Place name	L	φ
54	Kābulistān	104;40	35;0
55	Kashmīr	108;0	35;0
56	Rabāṭ Amīr	105;0	34;0
min iqlīm al-khāmis (belong to the Fifth Climate)			
57	Shamyāt	72;35	40;0
58	Akhlāt	75;50	39;20
	Third Circle		
ayḍā min iqlīm al-khāmis (also belong to the Fifth Climate)			
59	Barda^ca	83;0	40;30
60	Bukhārā	92;30	39;50
61	Samarqand	99;36	39;37
62	Khujand	105;30	41;55
63	Khutan	107;0	47;0
min iqlīm al-sādis (belong to the Sixth Climate)			
64	Tubbat	110;0	40;0
65	Kāshghar	106;30	44;0
66	Bīsh Bāligh	101;0	45;50
67	Khān Bāligh	124	46;0
68	Alān	83;0	44;0
min al-sābi^c (belongs to the Seventh [climate])			
69	Bulghār	90;0	49;0

BACK

On the back the entire rim is divided in 5°, 1° and 0;30° and numbered in 5s as 5—90; 90—5; 5—90; 90—5. In the upper left quadrant are drawn 60 horizontal

parallels, i.e., one for each 1/60 part of the Radius, and each fifth line is highlighted by dots. Also 11 quarter circles are drawn to divide the quadrant into 12 zones. In the opposite quadrant on the upper right, declination circles are drawn for each 10° of solar longitude. Each third of these arcs, which forms the boundary between two successive signs, is highlighted with dots. The names of the related signs are engraved in pairs along both radii. In each sign, the divisions of 10° are marked as 10, 20, 30.

Figure A014.6 – The Back of the astrolabe (photo by S. R. Sarma)

Shadow squares are drawn in the lower half, on the left for the base of 7 feet and on the right for the base of 12 digits. The vertical and horizontal scales are divided and

numbered accordingly. They are accompanied by the following labels:

Vertical scale on the left:	*ẓill aqdām ma^{c}kūs*	(reverse shadows in feet)
Horizontal scale on the left:	*ẓill aqdām mustawī*	(direct shadows in feet)
Horizontal scale on the right:	*ẓill aṣābi^{c} mustawī*	(direct shadows in digits)
Vertical scale on the right:	*ẓill aṣābi^{c} ma^{c}kūs*	(reverse shadows in digits).

Within the shadow squares is the table of triplicities in 4 columns and 12 rows. Here the names of the signs and the planetary regents are written in full and not with symbolic letters or numerals as on other astrolabes.

Table A014-3 Triplicities

Ātishī fiery	*Khaki* earthy	*Bādī* airy	*Ābī* watery
Aries	Taurus	Gemini	Cancer
Leo	Virgo	Libra	Scorpio
Sagittarius	Capricorn	Aquarius	Pisces

arbāb muthallathāth – shab the regents of the triplicities at night				*arbāb muthallathāth – rūz* the regents of the triplicities in the day			
Jupiter	Moon	Mercury	Mars	Sun	Venus	Saturn	Venus
Sun	Venus	Saturn	Venus	Jupiter	Moon	Mercury	Mars
Saturn	Mars	Jupiter	Moon	Saturn	Mars	Jupiter	Moon

The shadow squares are enclosed in a series of 11 semi-circular rows. Starting from outside, the first three rows carry the degree scales and the next two rows the cotangent scales. Thereafter, rows 6 and 7 are inscribed with the names of the 12 zodiac signs and the names of the 28 corresponding lunar mansions respectively. Then follow four rows containing the a table of limits and a table of decans and their regents.

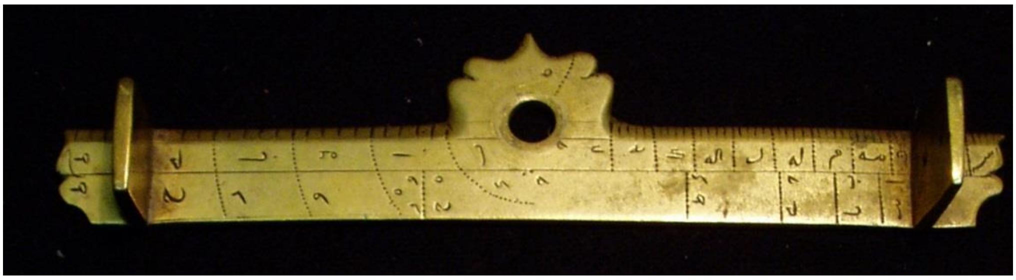

Figure A014.7 – Alidade (photo by S. R. Sarma)

ALIDADE

The straight bar alidade has ornate ends and an ornate centre-piece. The edge of the right half is graduated in divisions corresponding to the distances between the horizontal parallels in the sine quadrant, which are numbered on the surface, in 5s, from 5 to 60. On the left half is engraved the scale of solar longitude with curves matching the pairs of signs in the upper right quadrant, together with their serial numbers. In the lower register on the left, there are sundial markings for seasonal hours 9/4, 10/3, 11/2, 12/1, to be used when the alidade is employed as a sundial, with the sighting plate on the left functioning as the gnomon. The pin appears to be original. The wedge is a modern replacement.

BIBLIOGRAPHY

Maddison & Savage-Smith 1997, no. 129, pp. 223 and 225.

A015⊙ ASTROLABE ATTRIBUTABLE TO QĀ'IM MUḤAMMAD, NOT DATED

Diameter 330 mm

London, Nasser D. Khalili Collection of Islamic Art (#SCI 10)

Figure A015.1 – Front of the astrolabe (photo by S. R. Sarma)

This and the previous astrolabe, in spite of the substantial difference in size (diameter of 330 mm as against the diameter of 169 mm), are exactly alike in the technical aspects, with the same gazetteer and with the same configuration on the back.

The 5 plates also serve the same set of latitudes. What differentiates these two astrolabes are the artistic designs of the *kursī* and the rete. The workmanship of the present astrolabe is far superior and the rete displays a more elegant design.

COMPONENTS

Body with *kursī* (d. 330, h. 422, t. 12), shackle, rete, 5 plates. There is a rule, but no alidade; pin, wedge and ring are missing.

FRONT

The shackle is not trifoliate, but has ornate bases; it is too small for this large astrolabe. The *kursī* is solid; its profiles are made up of a series of ogees and lobes; the finial is not trifoliate but has the shape of a stylized diamond. The *kursī* is decorated on both sides with a pattern of flowers and leaves in high relief. The background is filled with a dark substance so that the pattern stands out. It is set with flush silver studs.

The limb is divided in 0;30°, 1° and 5° and numbered clockwise in 5s from 5 to 360.

RETE

The rete is more elegantly designed than in the previous astrolabe. But it is flat and lacks the final touches which would have given it a more contoured look. It is not known why it was left unfinished; when properly finished, it would have become one of the finest retes among the Lahore astrolabes.

A remarkable feature of this rete is that is completely devoid of the equinoctial and solstitial bars. The two rings of the Capricorn and ecliptic are held together by a floriated tracery with leaves and flowers with six petals. The ecliptic ring is divided into the 12 signs and labelled with their names; each sign is subdivided in groups of 6° and numbered from 6 to 30 separately in each sign. Star names are written on several leaves. But these names are not deeply incised and in many cases starkly abridged, so that deciphering them is rather difficult.

Figure A015.2 – Rete of the astrolabe (photo by S. R. Sarma)

PLATES

There are 5 plates. The first four plates carry altitude circles for every 2° and azimuth arcs for every 9° below the horizon. There are lines for seasonal hours which are numbered in common Arabic/Persian numerals from 1 to 12 between the circle of equator and the periphery. In addition, there are lines for *ghaṭīs* of 24 minutes which are drawn from the western horizon and numbered from there in *abjad* numerals from 1 to 34 along the circle of equator. On several plates the duration of the longest day is expressed in *ghaṭīs* and on a few in hours; neither set of values is very accurate.

Table A015-1 Plates

	φ	Longest Day in hours	in *ghaṭīs*
1a	19°		37
1b	20;40°		33
2a	32°		35
2b	35°		35
3a	36°	14	
3b	40°		37
4a	27°		34
4b	22°+30°	13;18 13;22	

The fifth plate carries the tablet of ecliptic coordinates on the obverse and the tablet of horizons on the reverse.

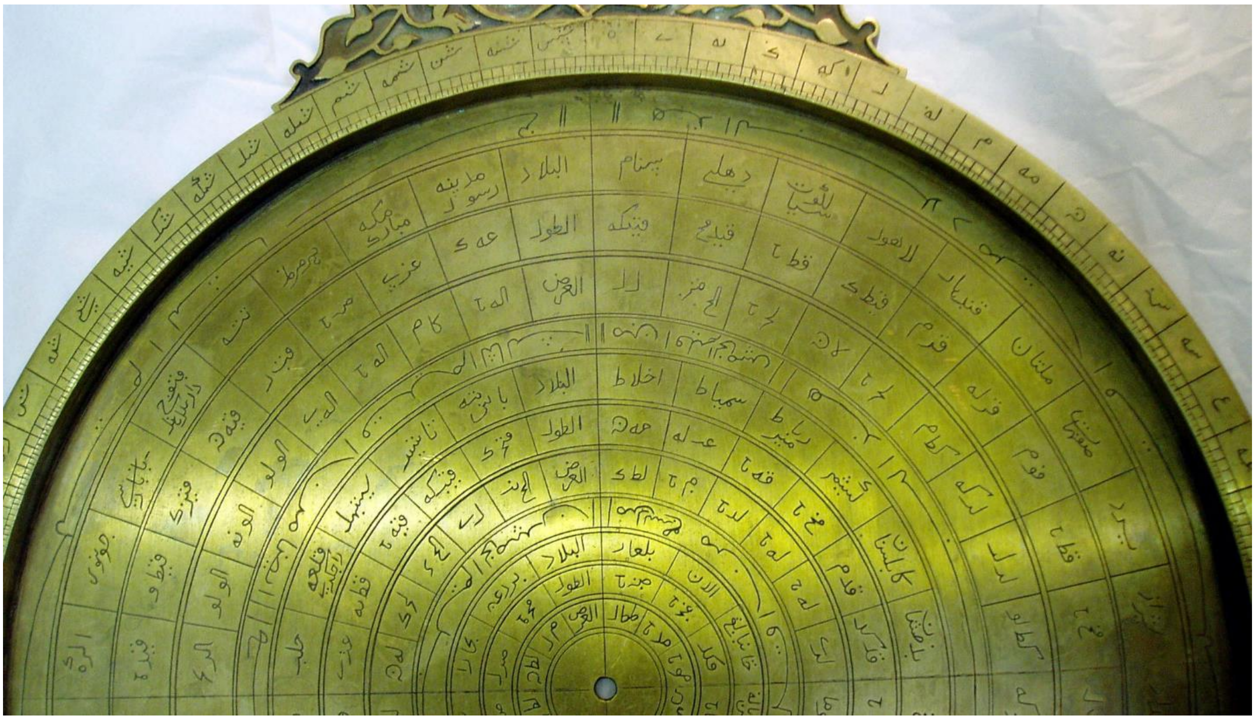

Figure A015.3 –

Figure A015.4 – Geographical gazetteer (photo by S. R. Sarma)

GEOGRAPHICAL GAZETTEER

Leaving aside minor scribal differences, the gazetteer is exactly the same as in the previous astrolabe, with the same number of 69 cities, mentioned in the same sequence with the same headings.

Table A015-2 Geographical Gazetteer

	Place name	L	φ
	First circle		
hazā al-bilād min iqlīm al-thānī (these cities belong to the Second Climate)			
01	Madīnat Rasūl	75;20	25;0
02	Makka Mubārak	77;10	21;40
03	Hurmūz	90;0	25;0
04	Tatta	102;7	25;10
05	Qannawj **Dār Mulk Hind**	115;50	26;36

	Place name	L	φ
06	Banārasī	117;20	26;55
07	Jawnbūr	119;6	26;36
08	Akra	114;0	27;3
09	Ajmīr	111;50	25;0
10	Kawāliyar	115;0	26;29
11	Ujjayn	102;0	22;30
12	Mandu	107;3	22;6
13	Burhānbū[r]	109;0	20;31
14	Kanbayāt	109;3	27;20
15	Ahmadābād **Kujarāt**	108;40	23;15
16	Dawlatābād **Dakkhin**	111;0	20;30
hazā al-bilād min iqlīm awwal (these cities belong to the First Climate)			
17	Ṣarmī Dar Mulk Ṣash[253]	65;0	9;30
18	ᶜAdan	76;0	15;0
19	Sanaᶜā' Dār Mulk Yaman	77;0	14;30
20	Bījābūr **Dakkhin**	105;30	17;20
21	Ahmadnakar **Dakkhin**	111;9	19;0
hazā al-bilād min iqlīm al-thālith (these cities belong to the Third Climate)			
22	Qayrawān	41;0	31;40

253 Should it read "Jarmī Dār al-Mulk Habasha' ?

	Place name	L	φ
23	Miṣr	63;20	30;20
24	Bayt al-Maqdis	66;30	31;50
25	Kūfa	79;30	31;30
26	Baghdād	80;30	33;25
27	Shīrāz	88;0	29;36
28	Yazd	89;0	34;34
29	Iṣfahān	86;40	32;35
30	Multān	107;35	29;40
31	Qandahār	107;40	33;0
32	Lāhūr	119;20	31;50
33	Siyālkūt	109;0	33;0
34	Dihlī	114;48	28;47
35	Sunām[254]	114;25	30;30
	Second Circle		
ayḍā min iqlīm al-thālith (also belong to the Third Climate)			
36	Bānībaht	113;20	28;52
37	Tānīsar	112;25	30;10
38	Yatbahal?	115;0	28;4
39	Qila Rājkarī	109;15	23;4
*hazā al-bilād min iqīm al-rābi*ᶜ (these cities belong to the Fourth Climate)			
40	Ḥalab	77;10	35;50
41	Marāgha	82;0	37;4

254 Spelt wrongly as Supnām

	Place name	L	φ
42	Tabrīz	82;0	38;0
43	Karkh	84;45	34;0
44	Qazwīn	85;0	36;55
45	Kāshān	85;0	34;0
46	Qumm	85;40	35;45
47	Rayy	86;20	35;0
48	Tāliqān	85;45	36;10
49	Ṭūs	92;30	36;0
50	Tūn	92;30	34;30
51	Harāt	94;13	34;30
52	Balkh	101;0	36;41
53	Badakhshān	104;24	32;10
54	Kābulistān	104;40	35;0
55	Kashmīr	108;0	35;0
56	Rabāṭ [A]mīr	105;0	34;0
min iqlīm al-khāmis (belong to the Fifth Climate)			
57	Shamyāt	72;35	40;0
58	Akhlāṭ	85;50	39;20
	Third Circle		
ayḍā min iqlīm al-khāmis (also belong to the Fifth Climate)			
59	Barda^ca	83;0	40;30
60	Bukhārā	92;30	39;50
61	Samarqand	99;36	39;37
62	Khujand	105;30	41;55

	Place name	L	φ
63	Khutan	107;0	60;0 !
min iqlīm al-sādis (belong to the Sixth Climate)			
64	Tubbat	110;0	40;0
65	Kāshghar	86;30	44;0
66	Bīsh Bāligh	101;0	45;50
67	Khān Bāligh	124	46;0
68	Alān	73;0	44;0
*min al-sābi*ᶜ (belongs to the Seventh [climate])			
69	Bulghār	90;0	49;30

BACK

The entire rim on the back is divided in 0;30°, 1°, 5° and labelled from 5 to 90, separately in each quadrant; the numbers start at the east and west points and reach the south and north points.

In the upper left quadrant are drawn 60 horizontal parallel lines and upon these are superimposed declination arcs, one for each sign of the zodiac or 30° solar longitude.

In the upper right quadrant, declination arcs are traced for every 6° of solar longitude. The names of the corresponding zodiac signs are engraved in full along the two radii, together with the numerical values (6, 12, 18, 24, 30) of the divisions of each sign. There are no graphs of the midday altitude of the sun in this quadrant.

In the lower half are drawn shadow squares, on the left for a gnomon of 7 feet and on the right for a gnomon of 12 digits. The vertical and horizontal scales are divided and numbered accordingly. The scales are accompanied by the following labels:

Vertical scale on the left: *ẓill aqdām mā*ᶜ*kūs* (reverse shadows in feet)
Horizontal scale on the left: *ẓill aqdām mustawī* (direct shadows in feet)
Horizontal scale on the right: *ẓill aṣābi*ᶜ *mustawī* (direct shadows in digits)
Vertical scale on the right: *ẓill aṣābi*ᶜ *ma*ᶜ*kūs* (reverse shadows in digits).

Inside the shadow squares is a table of triplicities with their planetary regents for the day as well as for the night, arranged exactly as in the previous astrolabe.

Figure A015.5 – Back of the astrolabe (photo by S. R. Sarma)

The shadow squares are enclosed in 11 semi-circular rows. Starting from the outside, the first three rows carry the degree scales and the next two the cotangent scales. Rows 6 and 7 contain respectively the names of the 12 zodiac signs and the names of

the 28 corresponding lunar mansions. Rows 8 and 9 display the limits and the last two rows the decans and their regents.

ALIDADE

There is no alidade with sights. There is, however, a rule engraved with declination scales, which is probably a late replacement.

BIBLIOGRAPHY

Maddison & Savage-Smith 1997, no. 132, pp. 230-231.

A016⊙ ASTROLABE ATTRIBUTABLE TO QĀ'IM MUḤAMMAD

Date ?, Lahore

Diameter 194 mm

London, Nasser D. Khalili Collection of Islamic Art (#SCI 36)

Figure A016.1 – Front of the astrolabe (photo by S. R. Sarma)

On this exquisitely crafted astrolabe, the Khalili catalogue states: 'The astrolabe is signed on the back, in the centre of the arcs of the signs, but the impression has been badly rubbed.' The catalogue then goes on to supply the rubbed off name of the maker as Muhammad Muqim ibn 'Isa ibn Allahdad Asturlabi Humayuni Lahori and date as AH 1003 (AD 1594-95).[255] When I examined the astrolabe in 2005, I looked very closely at that part which is said to contain the name of the maker; something was indeed rubbed off there, but it was impossible to detect any traces of the maker's name or of the date. It puzzles me how the authors of the catalogue could decipher the maker's name and the date.

The date, in any case, is highly improbable for Muqīm. If he did produce this splendid astrolabe in 1594-95, he must have been a mature and accomplished astrolabist at that time, of at least 25 years. This would place the year of his birth around 1570. But the astrolabes signed by him all pertain to the period from 1621 to 1659 and no astrolabe bearing a date between 1594 and 1621 came to light so far. Therefore 1594-95 cannot be the year of production of this astrolabe.

Stylistically the astrolabe may be attributed to Muqīm; but there are stronger stylistic reasons in favour of Muqīm's elder brother Qā'im Muḥammad. In the rete the names of zodiac signs along the rim of the ecliptic are cut in silhouette almost in the same manner as in Qā'im Muḥammad's astrolabe of 1627 (A011). The *zawraqī* horizons incorporated in the rete are reminiscent of the *zawraqī* horizons in Qā'im Muḥammad's astrolabe of 1635 at Oxford (A013). Muqīm did not incorporate *zawraqī* horizons in any of his astrolabes.

COMPONENTS

Body with *kursī* (d. 193, h. 270, t. 12), shackle and ring, rete (d. 171) for 38 stars. There survives only 1 plate (d. 171.5). Alidade is a replacement.

FRONT

The ring has an octagonal cross section. The shackle with a diamond cross-section has a trifoliate shape and trifoliate bases. The high *kursī* is intricately worked *à jour* with

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[255] Cf. Maddison & Savage-Smith 1997, I, pp. 220-223.

a cartouche in the middle. The cartouche was probably meant to carry the name of the owner, but it is blank. The profiles consisting of ogees at the base and top with a lobe in between are fashioned like ropes with engraved patterns on the surface. The *kursī* is topped by a trifoliate finial.

The limb is divided in 5°, 1° and 0;20° and labelled in 5s from 5 to 360. On the inner side of the mater, a gazetteer is engraved. The lug at the north point which is meant to hold the plates in position is lost. There is just a rectangular hole.

Figure A016.2 – Rete of the astrolabe (photo by S. R. Sarama)

RETE

The most striking part of the astrolabe is the rete which has a very unusual and very delicate design. On the rim of the only surviving plate a partial gazetteer is engraved and the Tropic of Capricorn drawn some distance away from the periphery. Therefore, in the rete also the Tropic of Capricorn does not run through the peripheral

ring as in other astrolabes, but lies a few millimetres inside this peripheral ring in the empty space.

The very plain peripheral ring and the highly ornate ecliptic ring are held together by the solstitial and the equinoctial bars. The solstitial bar is fully represented and it is without counter changes, its left hand side edge marking the meridian. The equinoctial bar, on the other hand, is shown as two separate segments, each of which has a counter-change at its intersection with the ecliptic ring. The segments are not straight but somewhat curved with the result that the line of equinoctial colure does not coincide with the edges of the equinoctial bar.

Unusually the ecliptic ring has counter changes at its two intersections with the equinoctial bar. In the upper half, the names of the six signs from *al-Mīzān* to *al-Ḥūt* are engraved in relief against the hatched background below the ecliptic circle. In the lower half, the names of the six signs from *al-Ḥamal* to *al-Sunbula* are cut in silhouette on the outer edge of the ecliptic circle. The base on which the silhouettes are set up and which is an extension of the ecliptic circle is hatched. In the upper surface of the ecliptic circle, the signs are divided into units of 6° and labelled in 6s from 6 to 30. These units are further subdivided into single degrees which are marked on the outer edge of the upper half of the ecliptic ring and on the inner edge of the lower half.

Near the centre the equinoctial bar makes way to two intersecting *zawraqī* or ship arcs which represent the oblique horizons at latitudes of 30° and 33°; these numbers are engraved in *abjad* on the respective arcs. It is not clear why these two latitudes are chosen. The plate to be used with these ship horizons is lost.

The space between the two rings is filled with a sparse tracery connecting the pointers to the stars which are south of the ecliptic. The space inside the ecliptic ring is filled by a denser tracery which connects the pointers of the stars situated to the north of the ecliptic. Here one or two star pointers may have broken and lost. Above the south point of the ecliptic circle is an arch to bridge the distance between the first point of Capricorn and the degree scale on the limb. The tip of the peripheral ring is joined to the arch by a leaf-shaped piece on the right. Such a piece on the left is broken and lost. A sturdy handle is affixed to the peripheral ring roughly at SW point. There are some construction marks on the reverse side of the rete.

Figure A016.3 – Detail of Figure A016.2, showing the names of the signs (from right to left) al-Ḥamal, al-Thawr, al-Jawzā', al-Saraṭān, al-Asad and al-Sunbula.

Following are the 38 star names engraved on the pointers.

Table A016-1 Stars on the Rete

	Star Name	Identification
01	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
02	*Rijl al-Musalsala*	γ Andromedae
03	*Baṭn al-Ḥūt*	β Andromedae
04	*Fam Qayṭus*	γ Ceti
05	*Ṣadr Qayṭus*	π Ceti
06	*Kaff al-Jadhmā'*	α Ceti
07	*Rās Ghūl*	β Persei
08	*Tālī Masāfat al-Nahr*	γ Eridani
09	*ᶜAyyūq*	α Aurigae
10	*Rijl al-Jawzā' [Yusrā]*	β Orionis
11	*Yad al-Jawzā' [Yusrā]*	γ Orionis
12	*Rijl [al-Jawzā'] Yumnā*	κ Orionis
13	*Shiᶜrā Yamānī*	α Canis Majoris
14	*Rās al-Taw'm al-Muqaddam*	α Geminorum
15	?	

	Star Name	Identification
16	?	
17	*Shiᶜrā Shāmī*	α Canis Minoris
18	*Ṭarafat Safīna*	ρ Puppis
19	*Fard al-Shujāᶜ*	α Hydrae
20	*Rās al-Asad*	μ Leonis
21	*Qalb al-Asad*	α Leonis
22	*Qāᶜidāt Bāṭiya*	α Crateris
23	*ᶜAnāq*	ζ Ursae Majoris
24	*Simāk Aᶜzal*	α Virginis
25	*Simāk Rāmiḥ*	α Bootis
26	*ᶜUnuq Ḥayyā*	α Serpentis
27	*Qalb al-ᶜAqrab*	α Scorpii
28	*Rijl al-Ḥawwā’*	ρ Ophiuchi
29	*[Rās al] Jāthī*	α Herculis
30	*Rās al-Ḥawwā’*	α Ophiuchi
31	*[Nasr] Wāqiᶜ*	α Lyrae
32	*Minqār al-Dajāja*	β Cygni
33	*[Nasr] Ṭā’īr*	α Aquilae
34	*Dhanab Dulfīn*	ε Delphini
35	*Fam Faras*	ε Pegasi
36	*Dhanab Jadī*	δ Capricorni
37	*Sāq Sākib al-Mā’ J[anūbiya]*	δ Aquarii
38	*Mankib Faras*	β Pegasi

PLATE

There survives just one plate out of possibly nine original plates. This plate is calibrated for latitude 27° on the obverse and for latitude 32° on the reverse. Interestingly, on both sides of the plate, the rim is engraved with the names and coordinates of 8 places which lie roughly on the same latitude for which the plate is calibrated. The purpose of this partial gazetteer is to show that the plate can be used for observation at all these eight places, because the differences in latitude are minimal.[256] Consequently the Tropic of Capricorn lies some distance away from the rim of the plates.

Obverse Side of the Plate

The obverse side of the plate carries stereographic projections for latitude 27°, the latitude of the Mughal Imperial City of Agra, referred to as *Dār al-Khilāfat Akbarābād* in the gazetteer engraved on the rim. The latitude 27° is mentioned in the middle of the plate as also the maximum duration of the daylight hours as 13;46.

On the plate the vertical and horizontal diameters are drawn as dotted lines. Altitude circles are traced for every 1° and every sixth line is highlighted with dots. These are numbered, on both sides of the meridian, in 3s along the equatorial circle and in 6s along the Tropic of Cancer. Azimuth arcs are drawn for every 6° below the horizon and numbered in a straight line below the lower limit to the Tropic of Cancer.

Plain lines are drawn for seasonal hours and numbered from 1 to 12 from the western horizon to the eastern horizon. Dotted lines are drawn for equal half-hours since the sunset and before the sunrise; these are numbered below the equatorial circle from 1 to 15 from the western horizon to the meridian to measure the half-hours elapsed from sunset to midnight; and from 1 to 15 from the eastern horizon up to the meridian to measure the half-hours that are still remaining before sunrise.

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256 This feature occurs on all the five plates in an undated astrolabe by Muqīm (A041). It is mentioned in the chronicle *Sīrat-i Fīrūzshāhī* (Sarma 2000) and can be seen in the bilingual astrolabe of 1616 (Sarma 2011a) and in a Gurmukhi astrolabe (Sarma 2012b). While discussing these, I emphasised, wrongly, that this feature belongs to an astrolabe tradition which is different from that the Lahore family. Now I stand corrected.

In the wide rim outside the Tropic of Capricorn, between the oblique horizon and the horizontal diameter are written *al-maghrib* on the west and *al-mashriq* on the east. Then below the horizontal diameter, from the west to the east, are inscribed the names of eight localities which are roughly on the latitude of 27°, together with their coordinates; the place names are written first in larger letters within round brackets, then the longitudes and latitudes in smaller letters, one below the other, separated by a straight horizontal line. The localities and their coordinates are reproduced below.

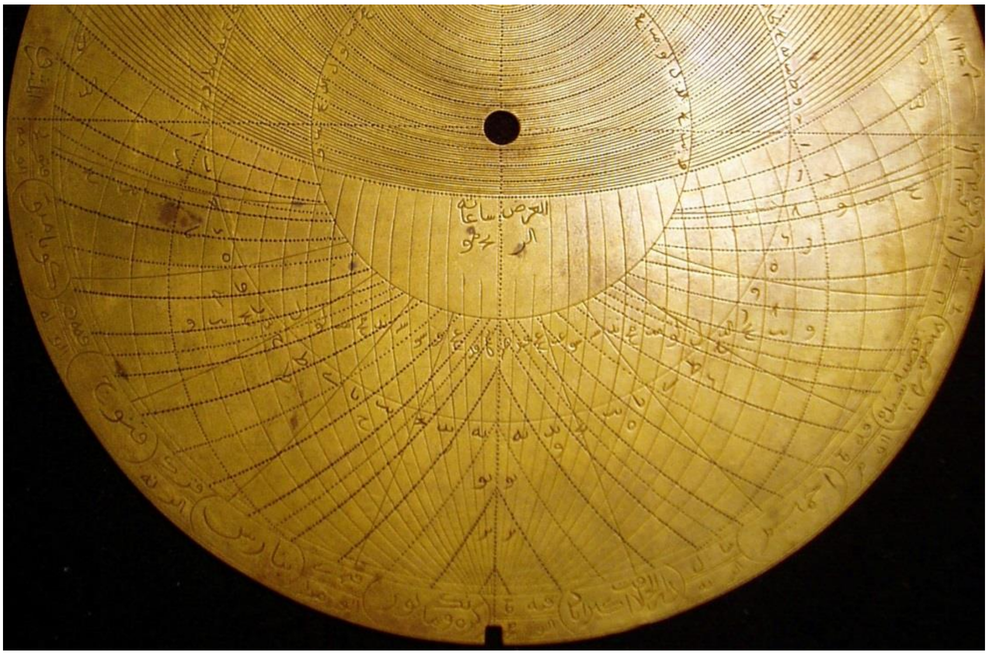

Figure A016.4 – Plate for atitude 27° (photo by S. R. Sarma)

Table A016-2 Places where this plate can be used

	Place Name	L	φ
1	Lamṭah wa Samī Nuwā	17;30	27;0
2	Qaṣba Mansūra Sindh	105;20	26;40
3	Ajmīr[257]	111;30	27;15
4	Dār al-Khilāfat Akbarābād	115;0	26;43

257 In the gazetteer engraved on the inner side of the mater, the coordinates of Ajmīr are different; long. 104;5 and lat. 26;0.

	Place Name	L	φ
5	Kara Mānikpūr	113;10	26;49
6	Banāras	112;20	27;55
7	Qannawj	115;50	26;35
8	Kūpāmayū	116;33	26;45

Reverse Side of the Plate

The reverse side of the plate is calibrated for latitude 32° which is the latitude of the Mughal Imperial City of Lahore, referred as ‘Dār al-Saltanat Lāhūr’ in the gazetteer on the rim. The latitude 32° is mentioned in the middle of the plate as also the maximum duration of the daylight hours as 14;8.

Here the altitude circles are drawn and numbered as on the obverse side. Azimuth arcs are drawn for every 6° below the horizon as on the obverse side, but numbered in a different manner; partly along the lines of seasonal hours and partly along Tropic of Cancer. Plain lines are drawn for seasonal hours and the intervals are numbered from 1 to 12 from the western to the eastern horizon. Dotted lines are drawn for *ghaṭīs* (of 24 minutes) counted from the western horizon and these are numbered from 1 to 30 from the western to the eastern horizon, the numbers being engraved along the circle of the equator.

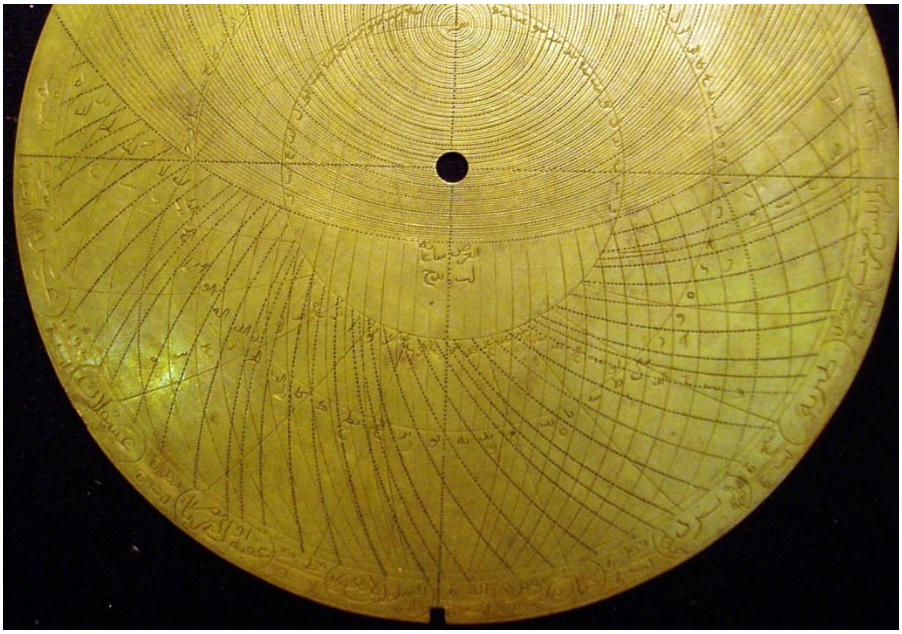

Figure A016.5 – Plate for latitude 32° (Photo by the Author)

Below the Tropic of Capricorn, the names of eight localities situated on the latitude of 32° and their coordinates are engraved as follows:

Table A016-3 Places where this plate can be used

	Place Name	L	φ	
1	Ṭarabulus Maghrib	66;30	32;0	Tripoli
2	Ṭiberiyya	68;0	32;0	
3	Yazd	89;0	32;0	
4	Kanār Bahr Rūm	25;0	32;0	Edge of the Roman Sea
5	Dar al-Saltanat Lāhūr	109;20	31;50	Lahore
6	cAqabah Daryā Miṣr	59;0	32;0	
7	cAsqalān	66;30	32;0	
8	cUrih-- ?	66;20	32;0	

Geographical Gazetteer

The gazetteer of 69 localities is arranged in three circles with varying patterns; in the first two circles, the data are inscribed in two different styles of cartouches, in the third circle in a spiral formation.

The localities are organized according to climates, which are mentioned at appropriate places above the three circles. Very few Indian towns are listed in this gazetteer. Lucknow occurs for the first time, but not Lahore and Agra probably because they are mentioned in the gazetteers engraved on the plate. Of the places outside India, Mecca and Medina are not listed, but they may have been listed on the respective plates.

Figure A016.6 – Geographical gazetteer (photo by S. R. Sarma)

Table A016-4 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
[-I] *az khaṭṭ istiwā’ tā iqlīm awwal* (from the equator to the first climate)			
01	Sāḥil Baḥr Awqiyānūs	11;0	0;0
02	Ghāna Ma^cadan al-Dhahab	39;0	10;0
03	Kūkū	14;0	10;0
04	Zaghāwa	66;0	1;10
05	Jamkūt	176;0	5;0
06	Kankandaz	180;0	0;0
[I] *al-iqlīm al-awwal 12 48* (the first climate [beginning at Lat] 12;48°)			
07	Dunqula	53;0	14;30
08	Jabil	75;0	13;00
09	Janad	75;30	14;30
10	Ṣana^cān	77;0	14;30
11	Damār	77;15	13;30
12	Jurshan	77;50	17;15
[II] *al-iqlīm al-thānī 20 31* (the second climate [beginning at Lat] 20;31°)			
13	^cAllāqī	68;0	47;15
14	Khaybar	75;20	24;20
15	Fayd	78;10	26;50
16	Kanbāyat	109;20	22;20
17	Dawlatābād	111;0	20;30
18	Kawāliyar	114;0	26;29

	Place Name	L	φ
19	Lakhnaū	114;53	26;30
20	Jawnbūr	119;6	26;36
21	Ajmīr	104;5	26;0
22	Awadh	118;6	27;22
23	Burhānbūr	113;0	20;30
[III] *al-iqlīm al-thālith 2734* (the third climate [beginning at Lat] 27;34°)			
24	Qayrawān	41;15	31;15
25	Mahdiyya	42;15	34;30
26	Miṣr	63;0	30;20
27	Bayt al-Maqdis	66;30	31;50
28	Dimashq	70;0	33;20
29	Baghdād	80;15	33;20
30	Iṣfahān	86;40	33;25
31	Fīrūzābād	87;30	28;10
	Middle Circle		
[III] *tatimma iqlīm al-thālith 27 34* (continuation of the third climate [beginning at Lat] 27;34°)			
32	Kirmān	91;30	30;5
33	Qandahār	107;40	33;0
34	Multān	106;25	25;40!
35	Sālkūt	109;0	33;0
36	Bānīhata	113;20	28;52 Panipat
37	Dihlī Dār al-Mulk Hind	113;35	28;39
[IV] *iqlīm al-rābiᶜ 33 43* (the fourth climate [beginning at Lat] 33;43°)			

	Place Name	L	φ
38	ᶜĀna	76;30	34;0
39	Qazwīn	105;0	36;15
40	Hamadān	83;0	36;0
41	Ḥalab	72;10	35;50
42	Harāt	94;20	34;30
43	Mashhad Qᶜuds	92;30	36;0
44	Astarābād	89;35	36;50
45	Kashmīr	105;0	35;0
46	Balkh	101;0	36;41
47	Badakhshān	104;25	36;10
48	Marāgha	80;0	36;20
49	Marw	97;0	37;40
[V] *al-iqlīm al-khāmis 39 1* (the fifth climate [beginning at Lat] 39;1°)			
50	Bardaᶜa	83;0	40;30
51	Samarqand	99;16	39;37
52	Khujand	105;35	41;55
53	Farghāna	104;0	42;20
54	Aylāq	99;10	43;20
	Inner Circle		
[VI] *al-iqlīm al-sādis 43 30* (the sixth climate [beginning at Lat] 43;30°)			
55	Halīqiya	20;0	46;0
56	Yanbalūna	34;55	45;15
57	Heraqla	67;20	46;30
58	Kāshghar	106;30	44;0

	Place Name	L	φ
59	Bīsh Bāligh	111;0	45;50
60	Khān Bāligh	124;0	46;0
[V] *al-iqlīm al-sābi*[c] *47 33* (the seventh climate [beginning at Lat] 47;33°)[258]			
61	Aqjākirmān	65;0	50;0
62	Qirqir	65;30	50;0
63	Ṭirnū	67;30	50;15
64	Araq	105;0	48;0
65	Ṣarāy	106;0	48;0
[VII+] *khārij az iqlīm ṭaraf shamāl* (beyond the climates in the northern extremity)[259]			
66	Mārīkirmān	65;50	50;0
67	Jazāīr Qūlī	*aṭwā*	64;0
68	Jazāīr Rūdjard	*lahāghīr*	62;0
69	Nahāyah Bahr Awqiyānūs	*ma*[c]*lūm*	71;0

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258 Elsewhere the latitude is 47;38°.

259 Nos. 67, 68, 69 are mentioned also in the gazetteer of Muqim's astrolabe of 1643 (A030) but without any longitudes, probably because these localities stretch over several longitudes. The words engraved in the column of longitudes in the present astrolabe are intriguing.

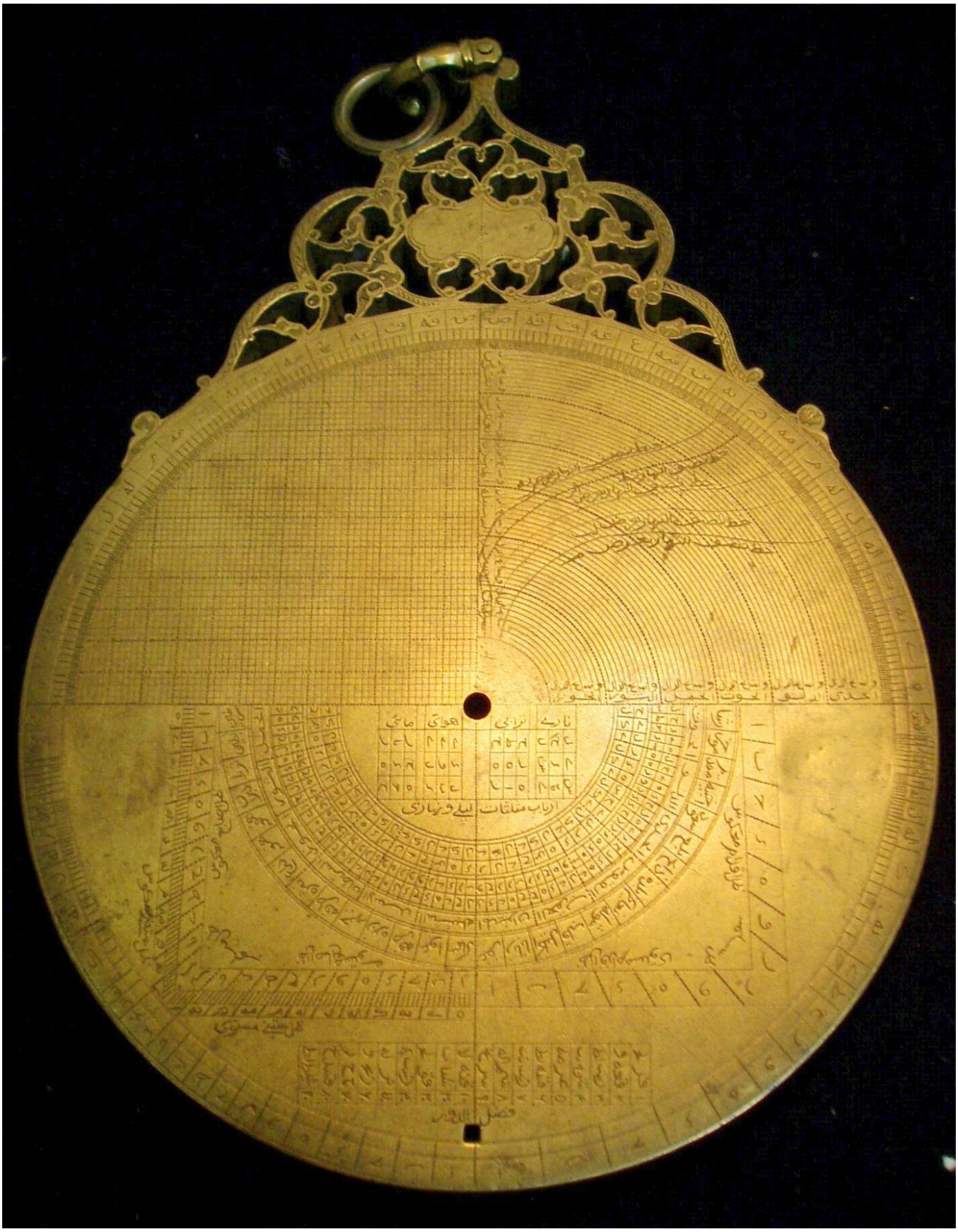

Figure A016.7 – Back of the astrolabe (photo by S. R. Sarma)

BACK

On the back the rim of the two upper quadrants carries the altitude scales which are divided in 5°, 1° and 0;20° and numbered as 5—90; 90—5.

The upper left quadrant is engraved with a sine-cosine graph with 60 horizontal and 60 vertical parallels, each fifth line being highlighted with dots. In the upper right is the solar quadrant with declination arcs for each 3° of solar longitude; of these every tenth arc which forms the boundary between two zodiac signs is dotted. The names of the signs as also the numbers of 1/5 parts of the signs are inscribed along the two radii. Five sigmoid curves for the meridian altitude of the sun throughout the year at the latitudes of 15°, 19°, 27°, 32° and 40° are plotted on this quadrant. These are labelled *khaṭṭ niṣf al-nahār bi- ᶜarḍ* followed by the value of the latitude in *abjad.*

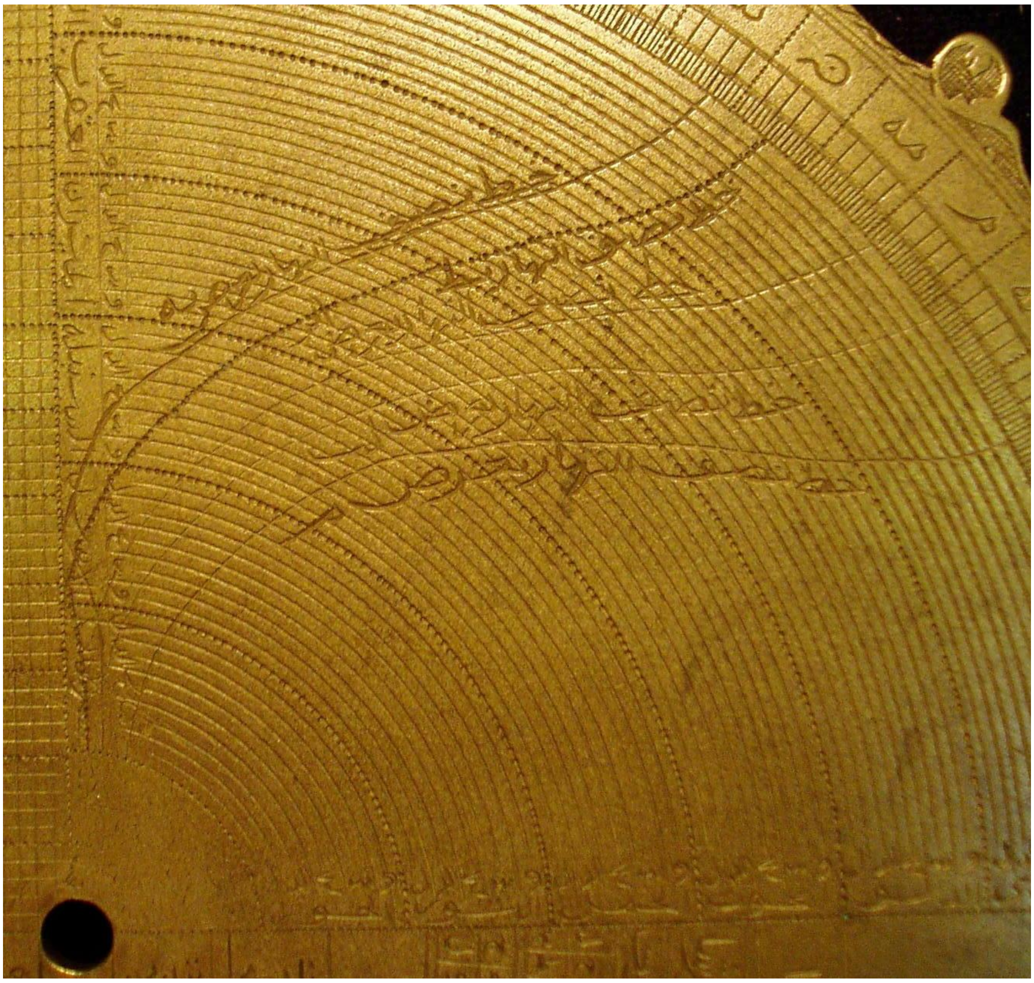

Figure A016.8 – Upper Right Quadrant with the five curves for the meridian altitude of the sun (photo by S. R. Sarma)

In the lower half are drawn the shadow squares, on the left for a base of 12 and 60 and on the right for a base of 7. On the left the vertical and horizontal scales have three bands each; first the scales are divided in 12 units and numbered accordingly in the inner band of the vertical scale and in the upper band of the horizontal scale. In the middle band, each unit (1/12th part) is divided in 5 sub-units. In the outer band these sub-units are numbered in 5s; from 5 to 60.

The vertical scale has the label *ẓill sullam aṣābi^c ma^ckūs* and the horizontal scale is accompanied by the label *ẓill sullam aṣābi^c mustawī.* These labels are inscribed inside the shadow squares. Outside the shadow squares, there are additional labels for the sexagesimal scale; to the left of the vertical scale is engraved *ẓill sattaynī ma^ckūs* and under the horizontal *ẓill sattaynī mustawī.*

The shadow square on the right is simpler. Here the horizontal and vertical scales are divided in 7 parts each and numbered accordingly. The horizontal scale is accompanied by the label *ẓill sullam aqdām mustawī* and the vertical scale by *ẓill sullam aqadām ma^ckūs.*

Within these shadow squares are engraved six concentric semi-circular rows. In the outermost row are engraved the names of the 28 lunar mansions and in the next row the names of the 12 corresponding zodiac signs. These are followed by two rows which contain a table of limits (*al-ḥudūd*) and two more rows containing a table of decans and their regents (*al-wujūḥ*). These semi-circular rows enclose a rectangular table which is engraved immediately below the horizontal diameter. Entitled *arbāb muthallathāt laylī wa nahārī*, this table displays the triplicities and their diurnal and nocturnal regents, divided in four sub-tables according to their natures, viz. fiery (*nārī*), earthy (*tarābī*), airy (*hawā'ī*) and watery (*mā'ī*).

Below the shadow squares is another rectangular table with the heading *faḍl al-dawr*, showing the multiples of differences in degrees and minutes between the length of the tropical year and 365 days.

On the rim of the lower half are engraved cotangent scales, on the left in digits and on the right in feet. The unequal divisions in the scale on the left are numbered clockwise from the meridian as 1, 2, 3, …15, 20, 25, … 90, followed by the label *al-aṣābi^c*. The unequal divisions in the scale on the right are numbered anticlockwise from the meridian as 1, 2, 3, …10, 15, 20, … 90, followed by the *label al-aqdām*.

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Maddison & Savage-Smith 1997, I, no. 126, pp. 220-223.

A017 ASTROLABE BY QĀIM MUḤAMMAD & MUḤAMMAD MUQĪM

Not dated

Diameter 120 mm[260]

Baghdad, Museum of Arab Antiquities (#9720) = National Museum of Iraq

CCA 3820=3826; Répertoire lists this astrolabe as Muḥammad Muqīm 2

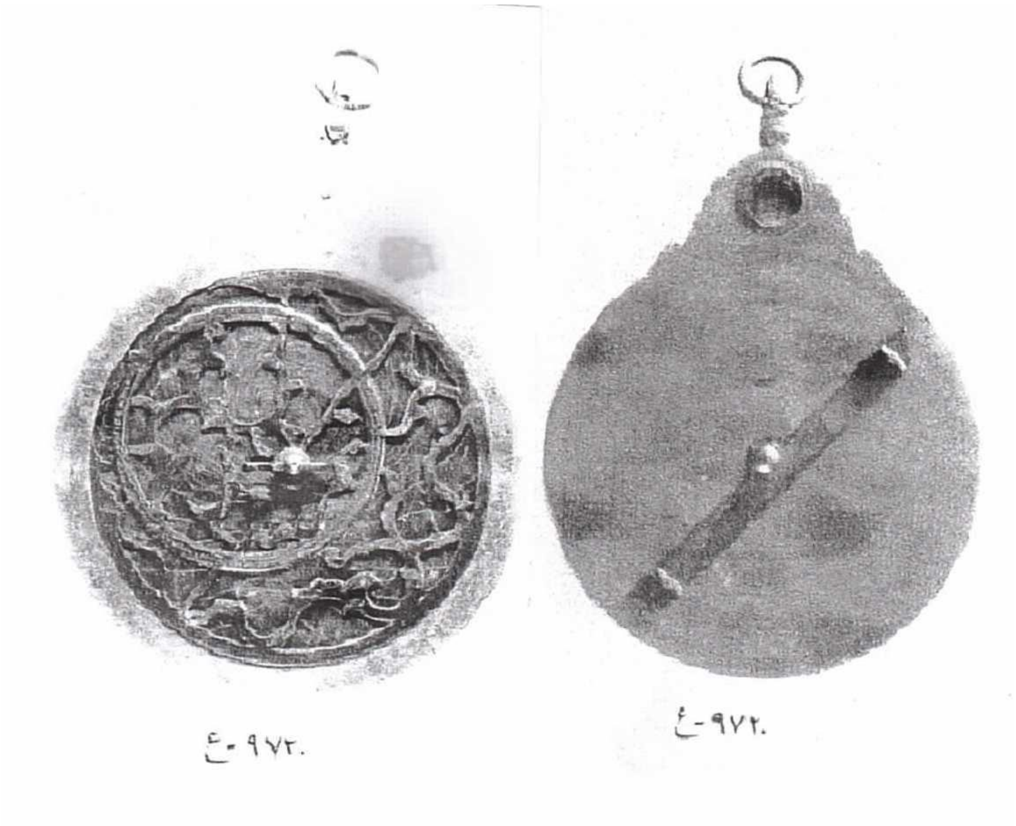

Figure A017.1 – Front and back of the astrolabe (from King 2005, p. 435)

The inscription on the back of this astrolabe is cited in the Répertoire:

> *tam al-ᶜamal bi-yadī aḍᶜafī al-ᶜbād qā'im muḥammad wa muḥammad muqīm ibnī mullā ᶜīsā ibn allāhdād asṭurlābī humāyūnī lāhūrī*
>
> 'The work was achieved by the hands of the weakest of the servants [of God], Qā'im Muḥammad and Muḥammad Muqīm, the two sons of Mullā ᶜĪsā, the son of Allāhdād of Lahore, the astrolabe maker of [the Emperor] Humāyūn.'

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[260] Both King and the Répertoire state that this astrolabe (#9720) and the one by Qā'im Muḥammad (A012) (#9721) measure 12 cm. But from the photos published in King 2005, p. 345, the relative dimensions of the two astrolabes at the Baghdad Museum can discerned: #9720 is 1.36 times larger than #9721. If #9721 measures 120 mm, #9720 should have a diameter of about 164 mm.

No date is mentioned in the inscription. The Répertoire estimates it c. 1018 = AD 1609/10, because the Hannover astrolabe by ‘the two sons of ᶜĪsā’ (A009) is dated in this year. But it is not certain if the expression ‘two sons’ in these astrolabes refers to the same pair of brothers. Even if it does, A008 is a juvenile work, whereas the present astrolabe appears to be a mature product of the 1620s.

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Faransīs & Naqshabandī 1957, pp. 25-28.

King 2005, pp. 434-435.

Répertoire, s.v. Muḥammad Muqīm, no. 2.

MUḤAMMAD MUQĪM

Muḥammad Muqīm (*fl.* 1621-1659) is the second son of Mullā ᶜĪsa and a grandson of the patriarch Allāhdād. He is a prolific astrolabe maker. There are extant 33 astrolabes and 1 celestial globe which bear his signature.[261] There are also eight unsigned astrolabes which can be attributed to him. He also produced an astrolabe jointly with his elder brother Qā'im Muḥammad (A017). There is yet another astrolabe in Hannover (A009) which is said to have been produced by the sons of ᶜĪsā (*ibnī ᶜīsā ibn allāhdād*), but it is uncertain whether these sons are indeed Qā'im and Muqīm and whether the inscription itself is authentic.

Muqīm's brother Qā'im made a name for himself in casting celestial globes by the *cire perdue* process. Muqīm seems to have produced just one single globe.[262] Muqīm's main forte is the astrolabe. Although he made a large number of astrolabes, he rarely repeats the design or even the size. The sizes of his astrolabes range from 344 to 45 mm in diameter. While the one with the diameter of 45 mm is the world's smallest astrolabe (A050), there are about a dozen small pieces with diameters measuring less than 100 mm. Neither the large ones nor the very small pieces are really convenient for actual use, but must have been highly prized collector's items at the Mughal court.

Unlike the other members of his family, he does not add non-standard features in his astrolabes. The only exception are two astrolabes with zoomorphic retes (A026) and

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[261] No images are available for 8 of the 33 astrolabes. It is possible that the same astrolabe was listed twice in the CCA or in the Répertoire. The Peabody Essex Museum, Salem, MA, holds an astrolabe (# M2560) which the Museum thinks is 'possibly by Muhammad Maqim (sic!) at Lahore' It may have been made by some member of the Lahore family, but it is difficult to decide which one. It will be discussed at the end of this section A among the unattributed astrolabes (A***). Répertoire 37 mentions an astrolabe by Muqīm in a private collection at New York, without any other particulars. I have a photocopy of the gazetteer of this astrolabe; it shows clearly that the astrolabe could not have been produced by Muqīm or any other member of the Lahore family. This astrolabe will be described in section B (B***). CCA 3565 records an astrolabe by Muqīm at the National Maritime Museum, Haifa. The museum sent me some images of the astrolabes in their holdings, but none of these can be by Muqīm. Anon 1989, p. 4, states that in the collection at Arriyadh 'Mughal astrolabist Muhammad Muqim [is] represented by three instruments.' It cannot be determined which the three are.

[262] Répertoire records, by mistake, two celestial globes: no. 12, dated 1049/1639-40, Kuwait, PC, and no. 17, dated 1067/1656-57, London, Victoria and Albert Museum (#2324-1883). The second globe is actually by Ḍiyā' al-Dīn as the inscription cited in the Répertoire clearly indicates.

(A051). While Allāhdād gives bird shapes to two star pointers, α Lyrae and α Aquilae, in his undated astrolabe (A002), the grandson Muqīm fills the retes with dozens of zoomorphic and anthropomorphic shapes.[263]

Muqīm's elegantly crafted *kursīs* are generally reticulated, but display much variety. Some have highly complex patterns; some others are pierced by just a few large incisions so that what remains looks like an arrangement of tulips, their flared petals forming the profiles of the *kursī* (A020, A021, A049, A058). Some *kursīs* are solid without any reticulation. In two cases florals patterns are engraved in low relief (A032 and A036); two others have extravagant profiles (A042 and A056).

Likewise, the floral traceries connecting the various star pointers in the rete also display much variety. A recurring motif in these retes are bell-shaped flowers or tulips with two flared petals, one long and another short, the longer petal usually forming the star-pointer.

The back contains a trigonometric quadrant in the upper left and a solar quadrant in the upper right with two sigmoid graphs for the latitudes of the two imperial cities of Agra (27°) and Lahore (32°). In three astrolabes (A040, A054, A057), lines for *ᶜasr* prayers are drawn in the solar quadrants. In A056 there is a universal horary quadrant in the upper right. In the lower half are engraved double shadow squares and an assortment of astrological tables. The latter vary according to size of the astrolabe. In smaller astrolabes, just two semicircular rows display the names of the 12 zodiac signs and the names of the 28 corresponding lunar mansions. In larger astrolabes, there are usually tables of the limits, faces or decans, triplicities, multiples of excess of revolution; sometimes also tables of climates.

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263 On zoomorphic astrolabes, see Gingerich 1987a.

A018 ASTROLABE BY MUḤAMMAD MUQĪM, AH 1030 (AD 1621-22)[264]

Diameter ca. 130 mm

PLU, Ex-Kazan, Russia

Répertoire 3

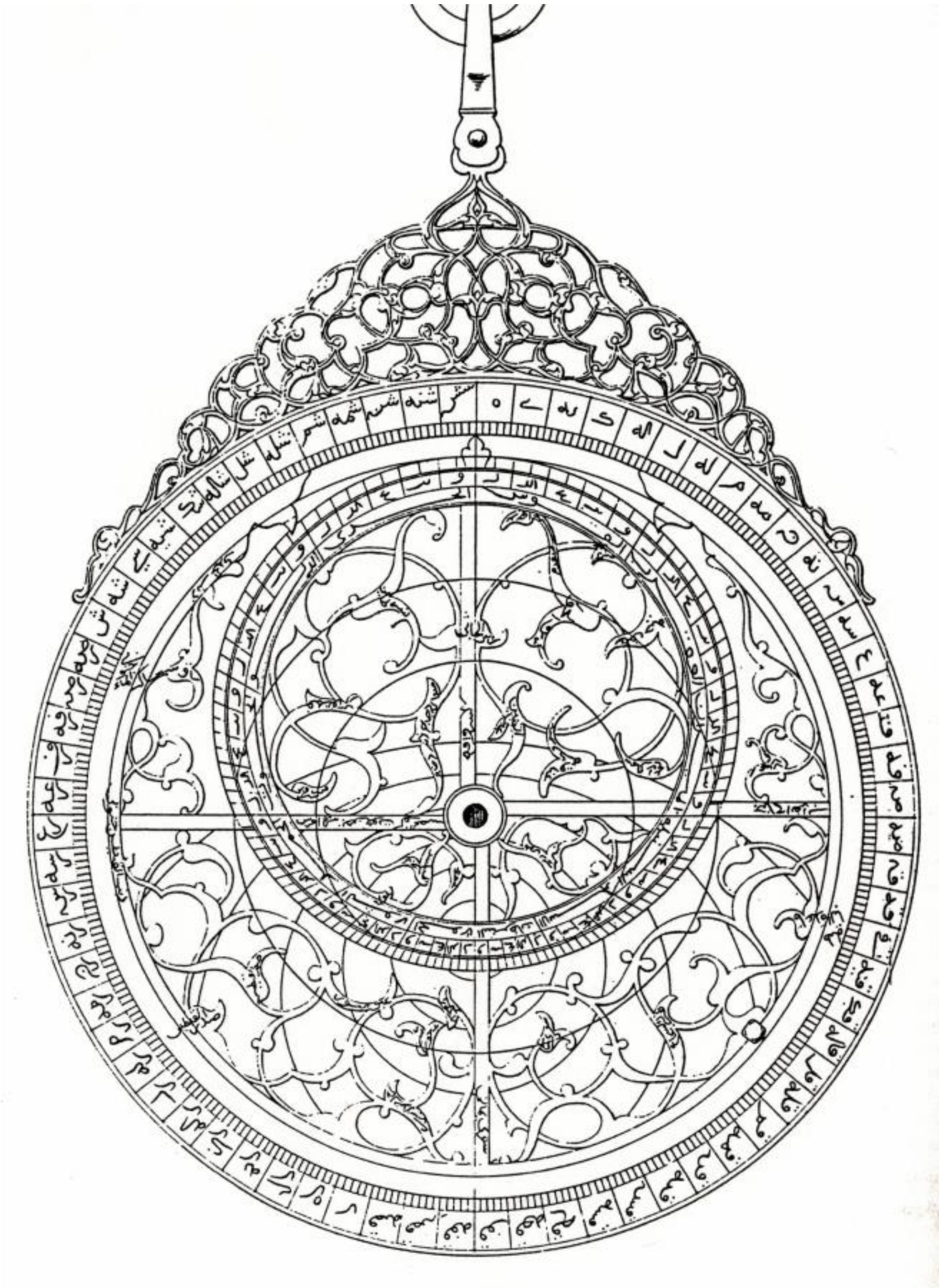

Figure A018.1 – Front of the astrolabe (from Dorn 1842)

264 Entry based on Dorn 1842.

This is the earliest extant astrolabe signed by Muḥammad Muqīm; even so it is a mature product displaying his technical and artistic skills. In 1842, when Dorn described it, it was in the private collection of Mirza Alexander Kasembeg who was a professor at the University of Kazan, the capital city of Tatarstan in Russia. It is not known what happened to the astrolabe subsequently. Perhaps it is in some private or public collection in Russia. Dorn provides excellent line drawings of the front and back of the astrolabe, which are so clear that all the inscriptions can be read and the beauty of the instrument appreciated. But, in his detailed description of the astrolabe, Dorn fails to mention the size of the astrolabe. It is probably of medium size, ca. 130 mm, as the altitude circles were drawn for every 3°on the plates.

COMPONENTS

Body with *kursī,* shackle and ring, rete for 38 stars, 5 plates, pin and horse. The alidade is missing.

FRONT

The ring is fairly large; the bases of the shackle are faintly trifoliate. The *kursī* is very intricately pierced with foliate design, with lobed profiles and a trifoliate finial. It is one of exquisitely crafted *kursīs* in the Indo-Persian astrolabes.

The scale on the limb is divided in 1° and 5° and numbered from 5 to 360 in clockwise direction.

RETE

The two rings of the Capricorn and ecliptic are held together by complete equinoctial and solstitial bars which are counter-changed at the centre. The space between the two rings and that inside the ecliptic ring is filled with arabesque tendrils with leaves and tulip-like flowers with two flared petals, one of which is much longer. This motif of tulips with two flared petals occurs in several astrolabes by Muqīm.

Table A018-1 Stars on the Rete

	Star Name	**Identification**
01	*Dhanab al-Qayṭus Janūbī*	β Ceti
02	*Batn al-Ḥūt*	β Andromedae

	Star Name	Identification
03	*Rijl al-Musalsala*	γ Andromedae
04	*Fam al-Qayṭus*	γ Ceti
05	*Ṣadr al-Qayṭus*	π Ceti
06	*ᶜAyn al-Thawr*	α Tauri
07	*ᶜAyyūq*	α Aurigae
08	*Rijl Jawjā' Yusrā*[265]	β Orionis
09	*Yad Jawjā' Yusrā*	γ Orionis
10	*Yad Jawjā' Yumnā*	α Orionis
11	*Shiᶜrā Yāmānī*	α Canis Majoris
12	*Shiᶜrā Shāmī*	α Canis Minoris
13	*Fard al-Shujāᶜ*	α Hydrae
14	*Ẓahr Dubb Akbar*	α Ursae Majoris
15	*Qāᶜidat al-Bāṭiya*	α Crateri
16	*ᶜAnāq*	ξ Ursae Majoris
17	*Janāḥ al-Ghurāb*	γ Corvi
18	*Simāk Aᶜzal*	α Virginis
19	*Simāk Ramiḥ*	α Bootis
20	*Nayyir Fakka*	α Coronae Borealis
21	*ᶜUnuq Ḥayya*	α Serpentis
22	*Rās al-Jāthī*	α Herculis
23	*Rās al-Ḥawwā'*	α Ophiuchi
24	*ᶜAyn al-Tinnīn*	γ Draconis

[265] Dorn 1842 records the name as *jawjā yasrā rijl.*

	Star Name	Identification
25	*Yad Ḥawwā' Yumnā Muqaddam*[266]	δ Ophiuchi
26	*Nasr Wāki*ᶜ	α Lyrae
27	*Minqār Dajāja*	β Cygni
28	*Nasr Ṭā'ir*	α Aquilae
29	*Dhanab Dajāja*	α Cygni
30	*Fam al-Faras*	ε Pegasi
31	*Dhanab al-Jadī*	δ Capricorni
32	*Sāq Sākib al-Mā' Janūbī*	δ Aquarii
33	*Mankib Faras*	β Pegasi
34	*Kaff al-Khaḍīb*	β Cassiopeiae
35	*Al-Faras Nathra*	?
36	?	
37	?	
38	?	

PLATES

There are five plates serving the following latitudes

Table A018-2 Plates

	φ	Longest Day
1a	35°	14;12 hours
1b	32°	14;8 hous

266 Dorn 1842 reads this as two stars: 17) *muqaddam* and 18) *yad ḥawwā yumnā*.

	φ	Longest Day
2a	36° (14;28 h) + 42° (15;5 h)	
2b	40°	14;52 hours
3a	25°	13;36 hours
3b	no inscription about the latitude	
4a	22°	13;21 hours
4b	27°	13;43 hours

Dorn does not describe the fifth plate; perhaps it contained the ecliptic coordinates on one side and the multiple horizons on the other. About the four plates, Dorn states that they carry altitude circles for every 3°, but does not mention the azimuths or hour lines. It is surprising that the projections for the two imperial cities of Agra (27°) and Lahore (32°) are not engraved on the two sides of the same plate as is done often in Mughal astrolabes.

GEOGRAPHICAL GAZETTEER

On the inner side of the mater a gazetteer of 63 localities with their longitudes and latitudes is engraved in two concentric circles. In the outer circle are listed Central Asian localities and in the inner circle several places of northern India. The localities are arranged roughly according to increasing longitude. It is remarkable that the enumeration does not commence with Mecca.

Table A018-3 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
01	Qayrawān	41;0	31;40
02	Miṣr	65;20	30;20
03	ᶜAdan	76;0	11;0

	Place Name	L	φ
04	Madīnat Rasūl		
	ᶜAlayhi al-Salām	75;20	25;0
05	Makka Muᶜaẓẓam	77;10	21;40
06	Hazar Baḥrayn	83;0	25;15
07	Bayt al-Maqdis	66;30	31;50
08	Dimashq	70;0	33;15
09	Ḥalab	72;10	35;50
10	Isṭanbul	59;50	45;0
11	Nakhjawān	81;15	38;40
12	Marāgha	82;0	37;20
13	Tabrīz	82;0	38;0
14	Bardaᶜa	85;0	40;30
15	Bāb al-Abwāb	85;0	43;0
16	Bulghār	90;0	49;30
17	Kūfa	79;30	31;30
18	Baghdād	80;0	35;25
19	Baṣra	84;0	30;11
20	Fīrūzābād	87;30	28;10
21	Yazd	89;0	32;0
22	Shīrāz	88;10	29;36
23	Hamadān	83;0	35;10
24	Qazwīn	85;0	36;0
25	Iṣfahān	86;40	32;25
26	Kāshān	86;0	34;10

	Place Name	L	φ
27	Astarābād	89;35	36;50
28	Busṭām	89;30	36;20
29	Sabzwār	91;20	36;5
30	Nīshābūr	92;30	36;21
31	Ṭūs	92;30	36;0
32	Harat	94;20	34;30
33	Marw	97;0	37;40
34	Balkh	101;0	36;41
35	Badakhshān	104;24	37;10
36	Bukhārā	97;30	39;50
37	Samarqand	98;35	38;37
38	Khujand	100;33	41;55
39	Kashghar	106;30	44;0
	Inner Circle		
40	Khutan	107;0	42;0
41	Hurmūz	92;0	25;50
42	Ghazna	104;20	33;35
43	Kābul	101;40	34;30
44	Peshawar	107;10	33;25
45	Dabīl	102;30	25;10
46	Bakir	105;0	27;40
47	Qandahār	107;40	33;0
48	Utsch ?	106;20	28;40
49	Multān	107;35	29;40

	Place Name	L	φ
50	Lāhūr	109;20	31;50
51	Siālkūt	109;0	33;0
52	Tubbat	110;3	40;0
53	Kashmīr	105;0	35;0
54	Sarandīb	130;0	10;0
55	Haḍrat Dihlī	108;35	28;15
57	Kannawj	105;50	26;33
58	Banāras	117;20	26;55
59	Tānesar	112;3	30;10
60	Akrah	114;0	27;13
61	Kawāliyar	115;0	26;29
62	Ujjayn	102;0	22;30
63	Kanbāyat	109;4	22;20

BACK

On the back, the entire rim is divided in 1° and 5° and groups of 5° are numbered from 5 to 90, separately for each of the four quadrants (not only for the two upper quadrants as is the common practice), starting from the east and west points and reaching up to the south and north points.

The upper left quadrant carries a trigonometric graph with 60 horizontal parallels. The solar quadrant on the right is divided by 18 declination arcs, one for each 10° solar longitude. On the two radii are marked the serial numbers of the zodiac signs and the 1/3 parts thereof as 10, 20, 30. Upon this quadrant are projected two graphs of meridian altitude of the sun in all seasons for the latitudes of 27° and 32°, which are the latitudes of the two imperial cities of Agra and Lahore. These carry the labels *khaṭṭ niṣf al-nahār ᶜarḍ k.z* and *khaṭṭ inṣf al-nahār ᶜarḍ l.b.*

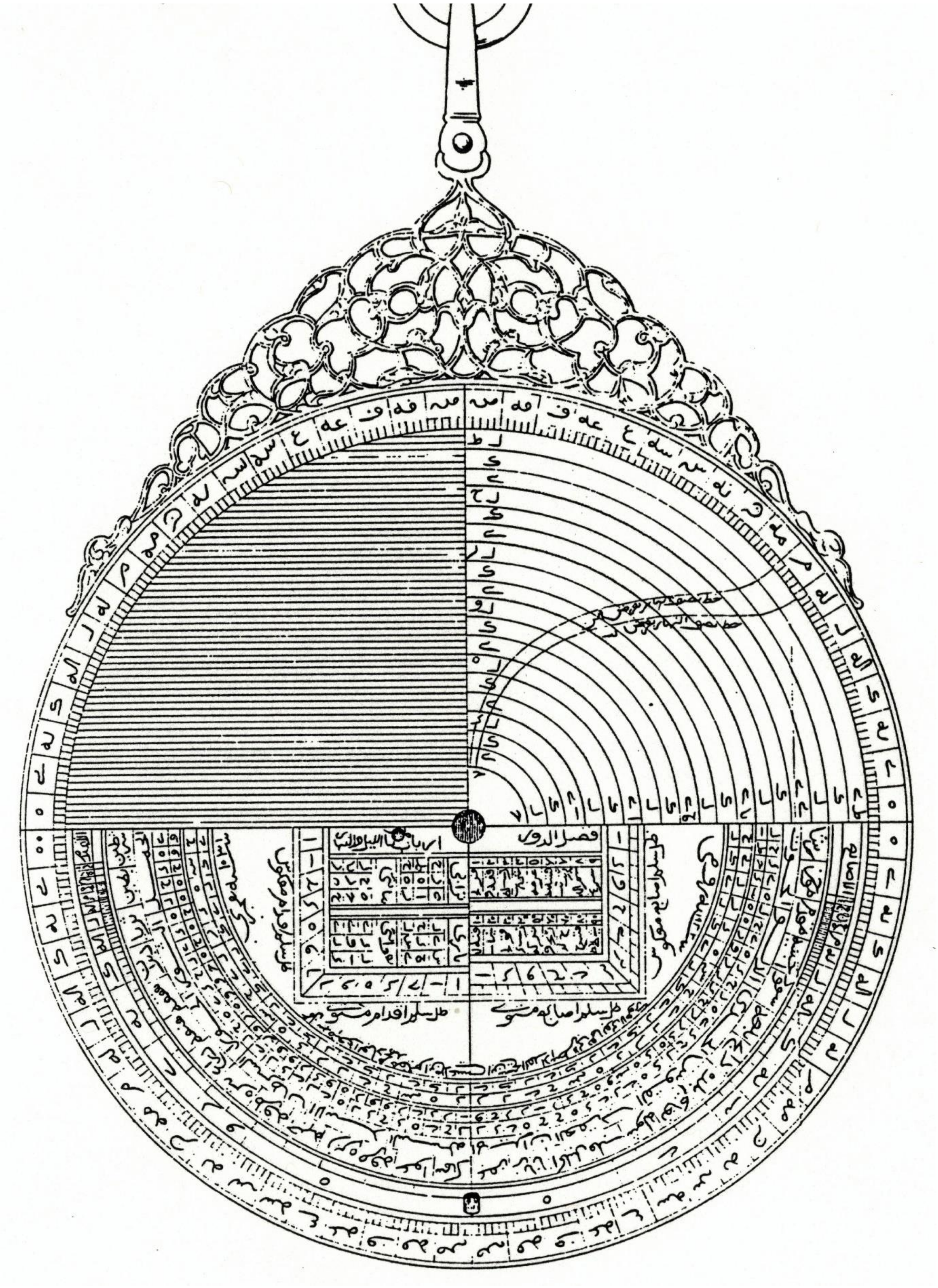

Figure A018.2 – Back of the astrolabe (after Dorn 1824)

There are two shadow squares in the lower half, on the left for a base of 7 and on the right for a base of 6/12. The vertical and horizontal scales on the left are divided into

7 parts and those on the right into 6 parts and numbered accordingly. The four scales are accompanied by the usual labels.

Vertical scale on the left: *ẓill sullam aqdām ma^{c}kūs*
Horizontal scale on the left: *ẓill sullam aqdām mustawī*
Horizontal scale on the right: *ẓill sullam aṣābi^{c} mustawī*
Vertical scale on the right: *ẓill sullam aṣābi^{c} ma^{c}kūs*

There are two tables inside these shadow squares. The table on the left has the heading *arbāb muthallathāt al-layl wa al-nahār* (regents of the triplicities at night and in the day). Here in the three rows in each category, the middle row shows the zodiac signs, the first row the regents of the night and the third row the regents of the day.[267] The signs are represented by their serial numbers (0 = Aries) and the planets by the last letters of their Arabic names.

Table A018-4 Triplicities

Fiery *nārī*				Earthy *tarābī*		
Sun	Jupiter	Saturn		Venus	Mercury	Mars
Aries	Leo	Sagittarius		Taurus	Virgo	Capricorn
Jupiter	Sun	Saturn		Moon	Venus	Mars
Airy *hawā'ī*				Watery *mā'ī*		
Saturn	Mercury	Jupiter		Venus	Mercury	Moon
Gemini	Libra	Aquarius		Cancer	Scorpio	Pisces
Mercury	Saturn	Jupiter		Mars	Venus	Moon

On the right is a table with the heading *faḍl al-dawr* (excess of revolution); it shows the multiples of the difference between the length of the tropical year and 365 days. It is the first time that this table appears on a Lahore astrolabe.

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267 The arrangement is different from the same table in the astrolabe of 1635 by Qā'im Muḥammad (A013).

Table A018-5 Excess of Revolution

1	87 33	10	155 31
2	175 6	20	61 2
3	262 39	30	106 33
4	350 12	40	262 4
5	77 45	50	57 35
6	164 19	60	213 6
7	252 52	70	08 37
8	340 25	80	164 8
9	67 58	90	319 39

Below the shadow squares, there are 10 concentric semi-circular rows. Starting from the outside, these rows contain the following.

1-2. Row 2 carries the degree scale as in the upper half, while the groups of 5° are numbered in row 2, as in the upper half.

3-4. The cotangent divisions on the shadow squares are projected on row 3. In the left half are the divisions in feet. There are 14 unequal divisions carrying the numbers 5, 6, 7, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60. At the end, just below the horizontal diameter is the word *al-qadām.* To the right of the meridian line, the band is divided in 13 unequal divisions, which are marked with the numbers, from the meridian onwards 5, 10, 12, 15, 20, 30, 35, 40, 45, 50, 55, 60, followed by the expression *al-aṣābi*ᶜ. In the next row are the subdivisions of the cotangent scales.

5. The names of the 28 lunar mansions

6. The names of the corresponding zodiac signs.

7-8. Rows 7-8 carry the table limits of signs (*ḥudūd*) as shown below.

Table A018-6 Limits of the Signs

Aries	Jupiter 6	Venus 6	Mercury 8	Mars 5	Saturn 5
Taurus	Venus 8	Mercury 6	Saturn 5	Jupiter 8	Mars 3
Gemini	Mercury 6	Jupiter 6	Venus 5	Mars 7	Saturn 6
Cancer	Mars 7	Venus 6	Mercury 6	Jupiter 7	Saturn 4

Leo	Jupiter 6	Venus 5	Saturn 7	Mercury 6	Mars 6
Virgo	Mercury 7	Venus 10	Jupiter 4	Mars 7	Saturn 2
Libra	Saturn 6	Mercury 8	Jupiter 7	Venus 7	Mars 2
Scorpio	Mars 7	Venus 4	Mercury 8	Jupiter 5	Saturn 6
Sagittarius	Jupiter 12	Venus 5	Mercury 4	Saturn 5	Mars 4
Capricorn	Mercury 7	Jupiter 7	Venus 8	Saturn 4	Mars 4
Aquarius	Mercury 7	Venus 6	Jupiter 7	Mars 5	Saturn 5
Pisces	Venus 12	Jupiter 4	Mercury 3	Mars 9	Saturn 2

9-10. Rows 9-10 display the decans (*wujūh*) and their lords, as shown below.

Table A018-7 Decans and Regents

Signs	**10°**	**20°**	**30°**
Aries	Mars	Sun	Venus
Taurus	Mercury	Moon	Saturn
Gemini	Jupiter	Mars	Sun
Cancer	Venus	Mercury	Moon
Leo	Saturn	Jupiter	Mars
Virgo	Sun	Venus	Mercury
Libra	Moon	Saturn	Jupiter
Scorpio	Mars	Sun	Venus
Sagittarius	Mercury	Moon	Saturn
Capricorn	Jupiter	Mars	Sun
Aquarius	Venus	Mercury	Moon
Pisces	Saturn	Jupiter	Mars

ALIDADE

The alidade is lost. There is a pin and a horse-headed wedge, both with matching tips.

INSCRIPTION

On the back, below the shadow squares, upside down along the semi-circular table:

> *ᶜamal bi-yad aḍᶜaf al-ᶜibād muḥammad muqīm ibn mullā ᶜīsā ibn shaykh allāhdād asṭurlābī humāyūnī lahūrī.*
>
> 'The work [done] by the hands of the weakest of the servants [of God] Muḥammad Muqīm, the son of Mullā ᶜĪsā, the son of Shaykh Allāhdād of Lahore, the astrolabe-maker of [the Emperor] Humāyūn.'

To the left of the shadow squares is engraved the date *sanah 1031 ḥijrī* ([in] the year 1031 Hijrī) and to the right *fī sanah 1933 rūmī* (in the year 1933 of the Rūmī era).

The Hijrī year 1031 corresponds to 16 November 1621 to 4 November 1622 and the year 1933 in the Rūmī or the Syro-Macedonian era to 11 October 1621 to 10 October 1622. The astrolabe therefore was completed during the period from 16 November 1621 to 10 October 1622.

BIBLIOGRAPHY

Dorn 1842.

A019⊙ ASTROLABE BY MUḤAMMAD MUQĪM, AH 1032 (AD 1622-23)

Diameter 67.5 mm

Paris, PC

Répertoire 4

Figure A019.1 – Front of the astrolabe (photo by S. R. Sarma)

This is Muqīm's second smallest astrolabe. On the inner side of the mater, there is a grid for the geographical gazetteer but it was not filled in, which is very unusual. The alidade also has unusual ends.

COMPONENTS

Body with *kursī* (d. 67.5, h. 91.5, t. 5.5), rete for 28 stars, 5 plates, alidade, pin and horse. Ring and shackle are missing.

FRONT

The *kursī* is worked *à jour*; the profiles are formed by ogees at the base and at the top, and two lobes in the middle; the finial is trifoliate. The front and back surfaces are not flat but elegantly contoured.

The limb is divided in 1° and 6° and numbered in 6s separately for each quadrant from 6 to 90 in the clockwise direction: 6—90; 6—90; 6—90; 6—90.

RETE

The narrow Capricorn ring and the much wider ecliptic ring are joined by the equinoctial bar with one counter-change. The ecliptic ring divided into the 12 signs of the zodiac and labelled, each sign is subdivided into groups of 6° and numbered. A large handle with a finely crafted tip on the rim is placed roughly between the west and south points. There are 12 star-pointers outside the ecliptic and 16 inside.

Figure A019.2 – Rete of the astrolabe (photo by S. R. Sarma)

PLATES

There are 5 plates; four of these carry altitude circles for each 6°, azimuths below the horizon for every 10°, and lines for seasonal hours. The plates have notches at the north point.

Table A019-1 Plates

	φ	Longest Day
1a	36°	14;28 hours
1b	0° + 90°	
2a	32°	14;8 hours
2b	40°	14;52 hours
3a	18°	13;5 hours
3b	27°	13;43 hours
4a	22°	13;21 hours
4b	24° + 22° (?)	
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

GEOGRAPHICAL GAZETTEER

The inner side of the mater is engraved with a grid of two circles which are divided by radial lines for 28 + 16 cells, but not filled in with a geographical gazetteer. At the north point is a small peg which fits into the notches made in the corresponding place on the plates.

BACK

The rim of the upper two quadrants bears an altitude scale divided in 1° and 6° and numbered as 6—90; 90—6.

The upper left quadrant with 30 horizontal parallels, each fifth highlighted with dots. The upper right quadrant is divided into 6 arcs, one for a pair of zodiac signs; their names are engraved along the two radii.

Figure A019.3 – Back of the astrolabe (photo by S. R. Sarma)

Shadow squares in the lower half. On the left for a base of 6/12, on the right for a base of 7. The vertical and horizontal scales are divided and numbered accordingly, with the usual labels.

The cotangent scales are extended to the rim of the lower half, inside which are two semi-circular bands bearing the names of the 12 zodiac signs and 28 lunar mansions respectively.

ALIDADE

The alidade is unusual, the line corresponding to the diameter of the astrolabe runs in the middle of the width and not on a side. There is no centre piece with the hole; instead the hole is in the width itself. The ends are shaped like lance-heads. It is does not carry scales. Obviously it is not original, but a replacement.

INSCRIPTION

Inside the shadow squares is the maker's inscription in two lines written upside-down:

> *ᶜamal bi-yad aḍaᶜaf al-ᶜibād muḥammad muqīm ibn mullā ᶜīsā*
> *ibn shaykh allāhdād asṭurlābī humāyūnī lāhūrī*
> 'The work [by] the hands of the least of the servants [of God], Muḥammad Muqīm, the son of Mullā ᶜĪsā, the son of Shaykh Allāhdād of Lahore, the astrolabe maker of [the Emperor] Humāyūn.

Below the shadow squares is written, also upside-down, *sanah 1032 hijrī* (AD 1622-23).

A020 ASTROLABE BY MUḤAMMAD MUQĪM, AH 1034 (AD 1624-25)

Diameter 86 mm

Istanbul, Kandilli Observatory (No. 6) [268]

Répertoire 5

Figure A020.1 – Front of the astrolabe (photo courtesy Professor Mustafa Aktar)

[268] It is a pleasure to record the help of Professor Mustafa Aktar of the Kandilli Observatory and Earthquake Research Institute for providing me the images and other details of this astrolabe.

COMPONENTS

Body with *kursī* (d. 86, h. 129, t. 7.4), shackle and ring, rete for 35 stars, 5 plates, alidade and pin. The horse is missing.

FRONT

The ring is plain; the shackle is also plain but with a trifoliate shape. The *kursī* is very high (45 mm) with an unusually broad base occupying about 120° of the limb. In the *kursī* four large incisions are made in the form of bells or upside-down tulip flowers so that the left out portion looks like an asymmetrical arrangement of five flowers, the outlines of their petals forming the profiles of the *kursī.* Lines engraved parallel to the edge of the *kursī* and parallel to the edges of the four incisions give depth and emphasis to the tulip-shape of the incisions. Such incisions in the *kursī* is a favourite motif of Muqīm and this motif occurs in different variations in some of Muqīm's other astrolabes.[269] The *kursī* is topped with a prominent trifoliate finial.

The limb of the astrolabe is divided in 1° and 6° and labelled in 6s from 6° to 360°.

RETE

In the openwork rete, the slender ring of the Tropic of Capricorn and the much broader ring of the ecliptic are held together by the equinoctial bar which has a counter change at the centre. The space inside the two rings is filled by a tracery which joins the various star pointers. The latter are mostly curved like tiger's claws and on these are engraved the names of the corresponding stars.

The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names. Each sign is divided into groups of 6° and these divisions are numbered as 6, 12, 18, 24, 30, separately for each signs. The sloped edge of the ecliptic ring is also divided into groups of 6°. The first point of Capricorn on the ecliptic ring is extended like a small finger to reach up to the degree scale on the limb. To facilitate the rotation

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269 For example, in the astrolabe made in the same year which is now in the Archaeological Museum at the Red Fort, Delhi (A019). See also A045 and A053.

of the rete around the centre, a large handle is mounted on the ring of the Tropic of Capricorn, midway between the west and the north points.

Because of the small size of the astrolabe, the star names are often too small to be deciphered fully. In most cases, the Arabic article *al-* is omitted in the star names. In the following table, the stars are arranged according to the increasing right ascension, starting from the vernal equinox.

Table A020-1 Stars on the Rete

	Star Name	Identification
01	*Dhanab al-Qayṭus al-Janūbī*	β Ceti
02	*Rijl al-Musalsala*	γ Andromedae
03	*Fam al-Qayṭus*	γ Ceti
04	*Ṣadr al-Qayṭus*	π Ceti
05	*Rās Ghūl*	β Persei
06	*Tālī Masāfat al-Nahr*	γ Eridan
07	*ᶜAyn Thawr*	α Tauri
08	*Rijl al-Jawjā' al-Yusrā*	β Orionis
09	*Yad al-Jawjā' Yumnā*	κ Orionis
10	*Shiᶜrā Yamānī*	α Canis Majoris
11	*Shiᶜrā Shāmī*	α Canis Minoris
12	?	?
13	*Fard al-Shujāᶜ*	α Hydrae
14	*Qalb al-Asad*	α Leonis
15	*Ẓahr Dub Akbar*	α Ursae Majoris
16	*ᶜAnāq*	ζ Ursae Majoris
17	*Qāᶜidat al-Bāṭiya*	α Crateri
18	*Janāḥ al-Ghurāb*	γ Corvi

	Star Name	Identification
19	*Simāk A^c^zal*	α Virginis
20	*Simāk Rāmiḥ*	α Bootis
21	*Nayyir Fakka*	α Coronae Borealis
22	*^c^Unuq al-Ḥayya*	α Serpentis
23	*Rās Jāthī* (?)	α Herculis
24	*Rās al-Ḥawwā'* (?)	α Ophiuchi
25	*^c^Ayn Tinnīn*	γ Draconis
26	[*Nasr*] *Wāqi^c^*	α Lyrae
27	*Minqar Dajāja*	β Cygni
28	*Nasr* (?) *Ṭā'ir*	α Aquilae
29	*Dhanab al-Dulfīn*	ε Delphini
30	*Dhanab Dajāja*	α Cygni
31	*Fam Faras*	ε Pegasi
32	*Dhanab al-Jadī*	δ Capricorni
33	*Sāk Aāqib al-Mā'*	δ Aquarii
34	*Mankib* (?) *Faras*	β Pegasi
35	*Kaff Khaḍīb*	β Cassiopeiae

PLATES

There are five plates with small rectangular notches cut at the north point. The peg at the corresponding place on the limb fits into these notches and holds them in place.

Table A020-2 Plates

	φ	Longest Day
1a	22°	13;22 hours

	φ	**Longest Day**
1b	25°	13;25 hours
2a	27°	13;46 hours
2b	32°	14;8 hours
3a	36°	14;32 hours
3b	40°	14;54 hours
4a	0°+90° Double Projection	
4b	18°+30° Double Projection	
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

On plates 1 to 3, altitude circles are drawn for every 6° and azimuth arcs for every 10° below the horizon. Both the sets are numbered in the usual style. There are plain lines for seasonal hours. On plate 1 (22° and 25°) there are dotted lines for equal hours as counted from the western and eastern horizons; on plates 2 and 3, the dotted lines for equal hours are drawn from the western horizon. On all the three plates, under the western horizon is written *al-maghrib* and under the eastern horizon *al-mashriq*.

Plate 4 carries double projections on both the sides. Therefore, it ought to have two notches at the north and south points so that both projections could be made use of, but no notch was cut at the south point.

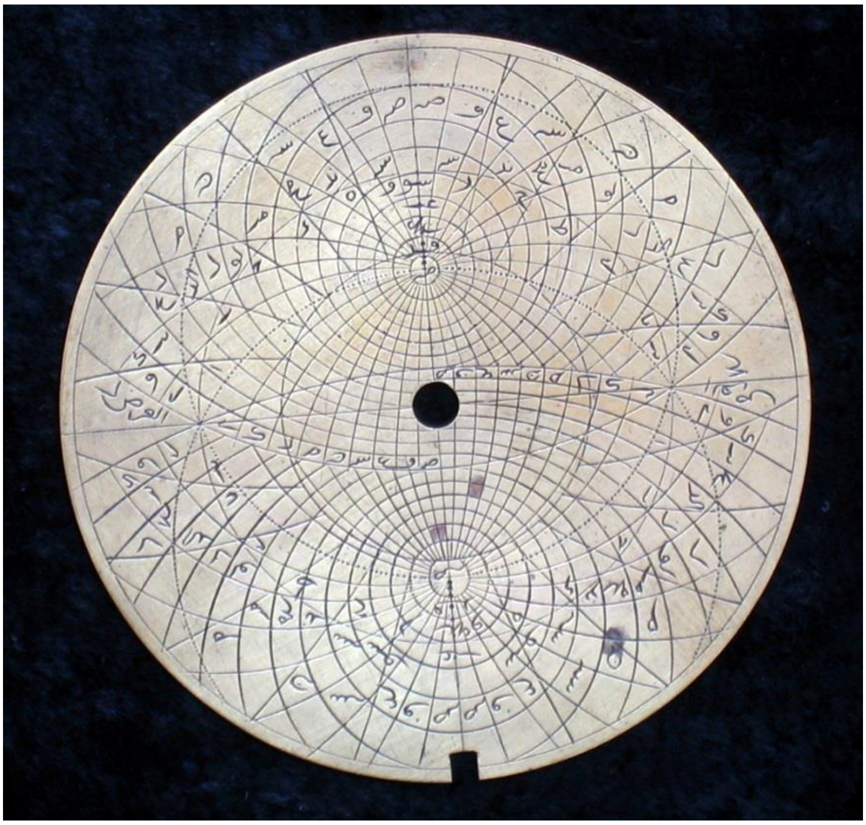

Figure A020.2 – Plate for latitudes 30° (above) and 18° (below)
(photo courtesy Professor Mustafa Aktat)

On 4a are engraved the stereographic projections for the zero latitude in the upper half and for 90° in the lower half. The equator and the tropic of Cancer are marked by dotted lines. In the upper half there are altitude circles for every 6° and azimuth lines for every 10°. Below the horizon are written on the west as well on the east lā carḍ lahu (there is no latitude).

In the lower half also altitude circles are drawn for each 6°. These are numbered from 6 to 90, starting from the equator and reaching up to the north celestial pole at the centre of the plate. Below the equator, the altitude circles from the equator up to the Tropic of Capricorn are numbered as 6, 12, 18 and 23;30. Lines for seasonal hours are drawn and numbered from 1 to 12, starting from the western horizon and reaching up to the western horizon. A little above the notch is a label stating carḍ tiscīn, 'latitude ninety [degrees]'.

Plate 4b carries double projections for the latitude 30° in the upper half and for the latitude of 18° in the lower half, with their respective oblique horizons. In both projections, prime meridians are drawn as dotted circles. In both halves the altitudes circles are drawn for every 6° in such a way that the circles for altitudes 6° to 48° in

the in the upper half take a S-turn at the meridian and continue as the altitude circles in the lower half. The altitude circles are numbered in 6s on the eastern and western sides in both halves. In both projections azimuth curves are drawn for 10 degrees and numbered separately in the two projections. Lines for seasonal hours are drawn in both projections and numbered from 1 to 12, starting from the western horizon. In the upper half, below the eastern horizon is the label *al-ᶜarḍ 30,* 'the latitude 30 [degrees]'. In the lower half also, there is a label below its eastern horizon which merely reads *al-ᶜarḍ 18,* 'the latitude 18'.

Plate 5a contains a stereographic projection relative to latitude 66;30°, which is the complement of the total obliquity of 23;30°. Besides the projections of the equator and the two tropics, it also contains the projection of the ecliptic. The arcs radiating from the centre are the lines of the celestial longitudes at intervals of 10° or one decan. The circles of celestial latitudes are drawn for each 6° and numbered from 6 to 90 to the north of ecliptic and from 6 to 23;30 to the south of the ecliptic. The names of the zodiac signs are written along the ecliptic circle and below them the numerical values of each decan. The names of the ten signs *al-Dalw, al-Ḥūt, al-Ḥamal, al-Thawr, al-Jawjā', al-Saraṭān, al-Asad, al-Sunbulah, al-Mīzān, al-ᶜAqrab* are engraved outside the ecliptic circle and the remaining two names *al-Qaws, al-Jadī,* inside the ecliptic circle. There is, however, no label identifying the plate.

On plate 5b are drawn four sets of half horizons for each 2°for latitudes from 8° to 66° in four sets thus:

Table A020-3 Latitudes of the Horizons

8	16	24	32	40	48	56	64
10	18	26	34	42	50	58	66
12	20	28	36	44	52	60	
14	22	30	38	46	54	62	

Scales of declination are marked along each radius, for both south and north, which are divided into 3 and 6 units and labelled 6, 12, 18 and 23;30, the last value being the obliquity of the ecliptic. There is, however, no label engraved identifying the plate.

Notches should have been cut at the four points of compass so that the four sets of horizons can be made use of, but there is only the notch at the north point as in the rest of the plates. Therefore, the horizon plate is not completely functional.

Figure A020.3 – Geographical Gazetteer (Photo courtesy Professor Mustafa Aktar, Kandilli Observatory)

GEOGRAPHICAL GAZETTEER

On the inner side of the mater is engraved a geographical gazetteer in two concentric circles, providing the names (*al-bilād*), logitudes (*al-ṭūl*) and latitudes (*al-ᶜarḍ*) of 50 (35 + 15) localities.

Table A020-4 Geographical Gazetteer

	Place Name	L	φ
	al-bilād	*al-ṭūl*	*al-ᶜarḍ*
	Outer Circle		
01	Miṣr	63;20	30;20
02	Madīnat Rasūl	75;20	25;0
03	Makka Mubārak	77;10	21;40
04	Bayt al-Maqdis	66;30	31;50
05	Ṭarābulus Shām	69;40	34;0
06	Dimashq	70;0	33;15
07	Ḥalab	72;10	35;50
08	Qusṭanṭiniyya	59;50	44;0
09	Ṣaṭīl?	59;50	45;0
10	Tabrīz	82;0	38;0
11	Baghdād	80;0	33;25
12	Baṣra	84;0	30;11
13	Rāmhurmūz	85;45	31;0
14	Kāzirūn	87;0	29;15
15	Fīrūzābād	87;30	28;10
16	Shīrāz	88;0	29;36
17	Yazd	89;0	32;0
18	Hamadān	83;0	35;10

	Place Name	L	φ
19	Sāwa	85;0	35;0
20	Qazwīn	85;0	36;0
21	Iṣfahān	86;40	32;25
22	Kāshān	86;0	34;0
23	Qum	85;0	34;45
24	Rayy	86;20	35;0
25	Sārī	88;20	34;0
26	Amul	88;20	36;15
27	Astarābād	89;35	36;50
28	Dāmghān	88;55	36;20
29	Nīshābūr	92;30	36;41
30	Mashhad	92;30	37;0
31	Tūn	92;30	34;30
32	Qā'īn	93;20	33;40
33	Harāh	94;20	34;30
34	Balkh	101;0	36;41
35	Badakhshān	104;24	37;10
	Inner Circle		
36	Bukhārā	97;30	39;50
37	Samarqand	99;36	39;37
38	Kāshghar	106;30	44;0
39	Khutan	107;0	42;0
40	Kirmān	91;30	30;5
41	Qandahār	107;40	33;0

	Place Name	L	φ
42	Mūltān	107;35	29;40
43	Lahāwar	109;20	31;50
44	Haḍrat Dihlī	114;18	28;4!
45	Akra	114;0	27;4!
46	Qannawj	115;50	26;35
47	Bānārasī	117;20	26;55
48	Burhānbūr	113;0	20;30
49	Sarāndib	130;0	10;0
50	Khanbāyat	109;4	22;20

BACK

On the back, the rim of the two upper quadrants carries the altitude scales which are divided in 1° and 6° and labelled 6—90; 90—6. The rim of the lower half carries the cotangent scales along with the subdivisions.

In the upper left is the trigonometric quadrant with 60 horizontal parallels where each sixth line is highlighted with dots. In the upper right is the solar quadrant with six concentric and equally spaced declination arcs. The corresponding zodiac signs are marked by their serial numbers along the two radii; 3 (Cancer) to 9 (Capricorn) along the vertical radius from the centre to the arc; and 9 (Capricorn) to 3 (Cancer) along the horizontal radius from the arc to the centre. It is surprising that the curves of the sun's midday altitude at the two latitudes of 27° and 32° (i.e., for the two Mughal imperial cities of Agra and Lahore) are not plotted on this quadrant, as is usually done on the other astrolabes by Muqīm.

In the lower half are drawn the shadow squares, on the left for a base of 7 feet and on the right for a base of 12 digits. The horizontal and vertical scales on both sides are divided and numbered accordingly and are accompanied by the following labels:

Vertical scale on the left: *ẓill sullam aqdām maᶜkūs*

Horizontal scale on the left: *ẓill sullam aqdām mustawī*

Horizontal scale on the right: *ẓill sullam aṣābi ᶜ mustawī*
Vertical scale on the right: *ẓill sullam aṣābi ᶜ maᶜkūs*

The shadow squares are enclosed in two semi-circular scales which display the relationship between the 12 signs of the zodiac and the 28 lunar mansions. In the outer semicircle are engraved the names of the 12 signs and in the inner semicircle those of the corresponding lunar mansions.

Figure A020.4 – Back of the astrolabe (photo courtesy Professor Mustafa Aktar)

Alidade etc

The alidade has ornate ends and an ornate cetre piece. One half of it is engraved with arcs which correspond to the declination arcs in the upper right quadrant and labelled with the serial numbers of the zodiac signs as in the same quadrant. The other half is divided into 60 equal parts which correspond to the 60 parallels in the upper left quadrant; these divisions are numbered in groups of 6, from 6 to 60. The two sighting vanes are equipped with two holes each. It looks as if the vanes were broken at some time and were welded to the star bar later. The pin is plain with a flat broad head, which looks like a washer. The hole through which the wedge passes has become corroded and elongated. The wedge is missing.

Inscription

Inside the shadow squares is engraved the signature of the astrolabe maker in three lines upside down:

aḍa[c]*af al-*[c]*ibād muḥammad muqīm ibn mullā* [c]*īsā*
ibn shaykh allāhdād asṭurlābī humā[yūn]ī
lāhūrī

'[Made by] the least of the servants [of God], Muḥammad Muqīm, the son of Mullā [c]Īsā, the son of Shaykh Allāhdād of Lahore, the astrolabe maker of [Emperor] Humāyūn.'

The year of the manufacture is engraved on the front side of the *kursī* in Hijrī era as *sanah 1034 hijrī* and on the back of the *kursī* in the Rūmī era as *sanah 1935 rūmī.*

Hijrī 1034 = 13 October 1624 – 1 October 1625.

Rūmī 1935 = 11 October 1623 – 10 October 1624.

Thus these two years do not coincide at any point. Probably Muqīm used a convention where the Rūmī year commences on 1 March (in the present case, on 1 March 1624). See also A020.

Bibliography

Dizer 1986, plate 7, where the astrolabe is erroneously attributed to [c]Īsā.

A021 ⊙ ASTROLABE BY MUḤAMMAD MUQĪM, AH 1034 (AD 1624-25)

Diameter 114 mm

New Delhi, Archaeological Museum, Red Fort (Registration No. 40,420; Acc. No. 66)

CCA 2700 =3723[270];Répertoire 6

Figure A021.1 – Front of the astrolabe (photo by Dr J-M. Delire)

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270 CCA 2700 lists a Lahore astrolabe dated 1034/1624 by M Muqim b Isa at DEN = Delhi National Museum; CCA 3723 refers to a Lahore astrolabe dated 1034/1624, with a diameter of 114 by the same person at DDA = Delhi, Archaeological Museum at Red Fort. The National Museum does not have such an astrolabe. The same astrolabe is recorded twice by mistake in the CCA. The *Répertoire* (no. 6) recognises the mistake and identifies the two as one and the same 2700 = 3723.

Components

Body with *kursī* (d. 114, h. 137, t. 6), ring, shackle, rete (d. 102) for 35 stars, 5 plates (d. 102). The pin and horse are missing. The components are held together now by a modern nut and bolt.

Front

A large ring with a diamond cross-section; the shackle has a trifoliate form, attached to the *kursī* by a copper pin. The *kursī* is pierced by 6 symmetric perforations so that what remains looks like a cluster of four tulips, their flared petals forming the profiles of the *kursī,* which is topped by a trifoliate finial. The surface of the *kursī* is plain and smooth without any decorations on both sides.

The limb is graduated in 1° and 6° and labelled from 6 to 360.

Rete

The two circles are held together by the equinoctial bar with counter change at the centre. There is a handle at NW on the band of the Tropic of Capricorn and a well-defined Capricorn index at the topmost point of the ecliptic ring. The ecliptic ring is divided in 12 signs and labelled with their names. Each sign is further subdivided into units of 6° and numbered. These divisions are extended into the sloping edge of the ecliptic circle. There are 35 star pointers which are joined by an almost symmetric floriate tracery, where the motif of tulips with flared petals (which dominates the design of the *kursī*) is repeated a few times. There is also a star-like flower with six petals just below the zero point of Capricorn.

Table A021-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus Janūbī*	β Ceti
2	*Batn al-Ḥūt*	β Andromedae
3	*Fam al-Qayṭus*	γ Ceti
4	*Ṣadr al-Qayṭus*	π Ceti
5	*Rās al-Ghūl*	β Persei

	Star Name	Identification
6	*Tālī Masāfat al-Nahr*	γ Eridani
7	*ᶜAyn al-Thawr*	α Tauri
8	*Al-ᶜAyyūq*	α Aurigae
9	*Rijl al-Jawjā' al-Yusrā*	β Orionis
10	*Yad al-Jawjā' al-Yumnā*	α Orionis
11	*Shiᶜrā Yamānī*	α Canis Majoris
12	*Shiᶜrā Shāmī*	α Canis Minoris
13	[*Ṭarfat al-Safīna*][271]	ρ Puppis
14	*Fard al-Shujāᶜ*	α Hydrae
15	*Ẓahr al-Dubb al-Akbar*	α Ursae Majoris
16	*Qāᶜidāt al-Bāṭiya*	α Crateris
17	*Ẓahr al-Asad*	δ Leonis
18	*ᶜAnāq*	ξ Ursae Majoris
19	*Janāḥ al-Ghurāb*	γ Corvi
20	*Simāk al-Aᶜzal*	α Virginis
21	*Simāk Rāmiḥ*	α Bootis
22	*Munīr [min] al-Fakka*[272]	α Coronae Borealis
23	*ᶜUnuq al-Ḥayya*	α Serpentis
24	*Rukbat al-Hawwā' al-Yusrā*	ρ Ophiuchi
25	*Rās al-Jāthī*	α Herculis

[271] By mistake, the astrolabist engraved the name *fard al-shujāᶜ* on two successive pointers; on this pointer the correct name is *ṭarfat al-ṣafīna.*

[272] Instead of the common designation *nayyir al-fakka,* Muqīm employs a rare designation used by al-Ṣūfī; cf. Savage-Smith 1985, p. 142: 'Al-Ṣūfī (*Ṣuwar*, 57) also calls it *al-munīr min al-fakkah.*' See also Muqīm's astrolabe of 1047/1637-8 (A023).

	Star Name	Identification
26	*Rās al-Ḥawwā’*	α Ophiuchi
27	*Al-Nasr al-Wāqi*ᶜ	α Lyrae
28	*Minqār al-Dajāja*	β Cygni
29	*Nasr Ṭā’ir*	α Aquilae
30	*Dhanab al-Dajāja*	α Cygni
31	*Fam al-Faras*	ε Pegasi
32	*Dhanab al-Jadī*	δ Capricorni
33	*Sāq Sākib al-Mā’*	δ Aquarii
34	*Surrat al-Faras*	δ Pegasi
35	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are five plates with the following specifications.

Table A021-2 Plates

	φ	Longest Day
1a	18°	13;3 hours
1b	29°	13;52 hours
2a	22°	13;21 hours
2b	24°	?
3a	27°	13;46 hours
3b	32°	14;8 hours
4a	0° + 90°	Double projection
4b	36° + 42°	Double projection
5a	Tablet of ecliptic coordinates	

	φ	Longest Day
5b	Tablet of horizons	

On plates 1a, 1b, 2a, 3a and 3b, altitude circles are drawn for every 6°, azimuth circles for every 10°, lines for seasonal hours and lines for equal hours since sunrise.

Plate 2b serving the latitude 24° (roughly the Tropic of Cancer) is unusual. It has altitude circles for each 6° above and below the horizon and azimuth circles for each 10° above and below the horizon, as well as curves for each of 10° of the astrological houses and lines for seasonal hours. The words *ᶜarḍ k-d,* 'latitude 24' are engraved in a small circle on the horizon.[273]

On plate 4a, there is a double projection for latitude 0° in the upper half and of latitude 90° in the lower half. Below the horizon on the east and west are mentioned the cardinal directions *al-mashriq* and *al-maghrib* respectively. There also the label *lā ᶜarḍ lahū* (no latitude for this), on both sides. In the lower half is written across the meridian line *ᶜarḍ tis ᶜūn,* (latitude ninety).

On plate 4b, there is again a double projection for latitudes 36° and 42° with altitude circles for each 6° and azimuth arcs for every 10° above the horizon.

The tablet of horizons has half horizons serving latitudes with even numbers from 4° to 66° in four batches:

4	12	20	28 … 60
6	14	22	30 … 62
8	16	24	32 … 64
10	18	26	34 … 66

Declination scales are divided at 6°, 12°, 18° and 23;30°.

GEOGRAPHICAL GAZETTEER

The gazetteer is engraved in two circles.

273 Cf. Qā'im's astrolabe of 1635 (A013); it has plate for 23;30° where the latitude circles are drawn both above and below the horizon; see Figure A013.4.

Table A021-3 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
01	Qayrawān	41;0	31;40
02	Miṣr	63;20	30;20
03	Madīnat Rasūl	75;20	25;0
04	Makka Muᶜaẓẓam	76;10	21;40
05	Bayt al-Maqdis	66;30	31;50
06	Ṭarābulus Maghrib	69;40	34;0
07	Dimashq	70;0	33;15
08	Ḥalab	72;10	35;50
09	Marāgha	82;0	36;20
10	Tabrīz	82;0	38;0
11	Kūfa	79;30	31;30
12	Baghdād	80;0	33;25
13	Baṣra	84;0	30;11
14	Fīrūzābād	87;30	28;10
15	Shīrāz	88;0	29;36
16	Yazd	89;0	32;0
17	Suhraward	83;20	36;30
18	Qazwīn	85;0	36;0
19	Iṣfahān	86;40	32;25
20	Mashhad	92;30	37;0
21	Harāt	94;20	34;30
22	Marw	97;0	37;40

	Place Name	L	φ	
23	Balkh	81;0	36;41	
24	Badakhshān	84;24	37;10	
25	Bukhārā	97;30	39;50	
26	Samarqand	99;36	39;37	
27	Khujand	100;35	41;15	
28	Kāshghar	106;30	44;0	
29	Khutan	107;0	42;0	
30	Hurmūz	92;0	25;0	
31	Ghazna	104;20	43;35	
	Inner Circle			
32	Kābul	104;40	34;30	
33	Dabīl	102;30	25;10	
34	Qandahār	107;40	33;0	
35	Multān	107;35	29;40	
36	Lahāwar	109;20	31;50	
37	Qannawj	115;50	26;35	
38	Bānārasī	117;20	26;15	
39	Sarandib	130;0	10;0	
40	Tubbat	110;0	40;0	
41	Kashmīr	108;0	35;0	
42	Haḍrat Dihlī	114;18?	28;39	
43	Akra	114;0	26;43	
44	Jānāpūr	119;6	26;36	Jaunpur
45	Ajmīr	112;0	26;0	

	Place Name	L	φ
46	Aḥmadābād	108;40	23;15

BACK

The rim of the two upper quadrants carries two altitude scales which are divided in 1° and 6° as in the front and labelled 6—90; 90—6. The rim of the lower half is inscribed with the cotangent scales. In the upper left quadrant are drawn 60 horizontal parallels, with each sixth highlighted with dots. The upper right quadrant is divided by declination arcs into 6 zones, one each for a pair of zodiac signs, which are marked along the two radii. Two graphs of solar meridian altitudes for the latitudes of 27° and 32° are drawn on this quadrant, with the usual labels.

In the lower half, there are shadow squares, on the left for a base of 7 feet and on the right for a base of 6/12 digits, with the usual labels. These shadow squares are enclosed in two semi-circles where the outer one carries the names of the 12 zodiac signs and the inner one those of the 28 lunar mansions.

Figure A021.2 – Back of the astrolabe (photo courtesy A. J. Turner)

ALIDADE

Straight bar alidade with ornate ends and ornate centre-piece graduated in both halves to match the divisions in the two upper quadrants.

Figure A021.3 – Maker's signature on the back (photo courtesy A. J. Turner)

INSCRIPTION

Inside the shadow squares is inscribed the signature of the maker in three lines:

sanah 20 julūs jahāngīrī sanah 1034

bi-yad aḍ^{c}af al-^{c}ibād muḥammad muqīm ibn mullā ^{c}īsā

ibn shaykh allāhdād asṭurlābī lāhūrī humāyūnī

'[In] the regnal year 20 of [the Emperor] Jahāngīr, in the year 1034 [Hijrī] [this astrolabe was made] by the hand of the weakest servant [of God], Muḥammad Muqīm, son of Mullā ^{c}Īsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.'

Hijrī 1034 = 13 October 1624 – 1 October 1625. The 20th regnal year of Jahāngīr commences approximately on 9 March 1625. Therefore, the astrolabe was completed between 9 March and 1 October 1625.

BIBLIOGRAPHY

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Sen 1990.

A022 ASTROLABE BY MUḤAMMAD MUQĪM, AH 1034 (AD 1624-25)

Diameter 84 mm

Samarkand, The Samarkand Museum of History and Art of Uzbek People (#131, A.172.2)

Répertoire 7

The Répertoire cites the following inscription:

*aḍ*ᶜ*af al-*ᶜ*ibād muḥammad muqīm ibn mullā* ᶜ*īsā ibn shaykh allāhdād asṭurlābī humāyūnī lāhūrī sanah 1034 hijrī sanah 1935 rūmī*

'[Made by] the weakest of the servants [of God], Muḥammad Muqīm, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, [in] the year 1034 of Hijra, [in] the year 1935 of the Rūmī era.'

Hijrī 1034 = 13 October 1624 – 1 October 1625

Rūmī 1935 = 11 October 1623 – 10 October 1624

Thus these two years do not coincide at any point. Probably Muqīm used a convention where the Rūmī year commences on 1 March (in the present case, on 1 March 1624). See also A018.

No other information is available. A letter addressed to the Samarkand Museum of History and Art of Uzbek People came back undelivered.

A023⊙ ASTROLABE BY MUḤAMMAD MUQĪM, AH 1047 (AD 1637-38)

Diameter 94.5 mm

PLU, ex. PC, Brussels

CCA 2061; Répertoire 8

Figure A023.1 – Front of the astrolabe (photo courtesy A. J. Turner)

Components

Body with *kursī* (d. 94.5, h. 121.5, t. 6), shackle and ring, rete for 27 stars, 5 plates, alidade, pin and horse. The alidade is uninscribed and is a replacement.

Front

The ring and shackle have diamond cross-section. The *kursī* is worked *à jour* with lobed profiles and a trifoliate finial. The limb is graduated in 1° and 6° and the groups of 6° are numbered clockwise from 6 to 90, separately for each quadrant.

Rete

The Capricorn ring and the ecliptic ring are held together by the equinoctial bar with three counter changes and by the solstitial bar which is interrupted twice by inverted arch-like forms. There are 27 star pointers.

Plates

There are five plates, four of which serve eight different latitudes between 22° to 40°. On these four plates, altitude circles are drawn for every 6°; azimuth arcs are drawn sometimes below, sometimes above and other times both above and below the horizon. There are lines for seasonal hours on all four plates, some have lines for equal hours since sunrise while others have also lines for equal hours before sunrise. The duration of the longest day is erratic as in a few other astrolabes.

Table A023-1 Plates

	φ	Longest Day
1a	22°	13;21 hours
1b	25°	13 hours!
2a	27°	13;13 hours!
2b	30°	13;58 hours
3a	32°	14;8 hours
3b	36°	14;32 hours

	φ	Longest Day
4a	40°	14 hours!
4b	0° + 18°	double projection
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

GEOGRAPHICAL GAZETTEER

The gazetteer provides, in three circles, the longitude, names and latutudes of 65 localities, in this order.

Figure A023.2 – Geographical gazetteer (photo by S. R. Sarma)

Figure A023.3 – Back of the astrolabe (photo by S. R. Sarma)

BACK

The two upper quadrants carry the same scales on the rim as in the front, and labelled 6-90; 90-6. The two lower quadrants have cotangent scales on the rim.

The upper left quadrant carries a cosine graph with 30 horizontal parallels, each third of which is highlighted. In the upper right quadrant are drawn 5 declination arcs; on the vertical and horizontal diameters are marked the corresponding signs of the zodiac with the serial numbers. On these are plotted two sigmoid curves for the latitudes 27° (Agra) and 32° (Lahore); the labels read *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27* respectively.

In the lower half are shadow squares, on the left for a base of 12, on the right for a base of 7. The vertical and horizontal scales are divided and labelled accordingly. Inside these squares, there is a semicircular table with the names of the 12 zodiac signs and those of the corresponding 28 lunar mansions.

INSCRIPTION

Within the semi-circular table is engraved the signature of the maker:

ṣan ᶜat muḥammad muqīm ibn ᶜīsā ibn
allāhdād asturlābī humāyūnī
lāhūrī

'The work of Muḥammad Muqīm, son of ᶜĪsā, son of Allahādad of Lahore, the astrolabe maker to [the Emperor] Humāyūn.'

Below the shadow squares is the date: *fī sanah* 1047 (in the year 1047) which corresponds to AD 1637-38.

PROVENANCE

Exhibited in 1984 in Brussels; then in it was in a private collection. Came up for auction at Sotheby's on 12.7.91. In 1996 it was in a private collection at Brussels when I saw it. Again it came up for auction at Christie's on 17 May 2007.

BIBLIOGRAPHY

Anon 1985.

Christie's catalogue of 17 May 2007, lot 88.

A024 ASTROLABE BY MUḤAMMAD MUQĪM, AH 1047 (AD 1637-38)[274]

Diameter 256 mm

Islamabad, Islamabad Museum (# ID 186)

CCA 2704; Répertoire 9

Figure A024.1 – Front of the astrolabe (photo by Mubashir Ul-Haq Abbasi)

274 This entry is an abridged version of Abbasi & Sarma (forthcoming).

Components

Body with *kursī* (d. 256, h. 375), rete (d. 240) for 46 stars, 5 plates, washer, alidade, and horse; the alidade is a replacement.

Front

With its delicate fretwork, the *kursī* is one of the most exquisitely crafted *kursīs* to be found in Lahore astrolabes. The two profiles are made up of ogees at the base and top with a lobe in between. The finial has the shape of a trefoil, so also the shackle. The ring is plain. On a cartouche in the middle of the *kursī* is engraved the following in Persian: *az ghafūr maghfirat umīd dāram* (I hope to be forgiven by the Forgiver). The limb carries a degree scale which is divided in 1° and 5° and labelled from 5 to 360.

Figure A024.2 – Rete of the Astrolabe (photo by Mubashir Ul-Haq Abbasi)

Rete

In the rete, the broad ring of the ecliptic is joined to the Tropic of Capricorn by the equinoctial bar, which has counter changes at its two intersections with the ecliptic ring.

The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names. Each sign is subdivided into group of 5° and numbered accordingly. These units of 5° degrees are divided into single degrees on the sloping edge of the ecliptic ring. There are 46 star pointers which are joined by a nearly symmetric tracery. There is a small knob to the right of the north point for rotating the rete. The 46 star pointers represent the following stars.

Table A024-1 Stars on the Rete

	Star Name	**Identification**
01	*Dhanab al-Qayṭus al-Janūbī*	β Ceti
02	*Baṭn al-Ḥūt*	β Andromedae
03	*Rijl al-Musalsala*	γ Andromedae
04	*Fam al-Qayṭus*	γ Ceti
05	*Ṣadr al-Qayṭus*	π Ceti
06	*Kaff al-Jadhmā'*	α Ceti
07	*Rās al-Ghūl*	β Persei
08	*Thānī Masāfat al-Nahr*	θ Eridani
09	*Dabarān*	α Tauri
10	*Al-ᶜAyyūq*	α Aurigae
11	*Rijl al-Jawzā' al-Yusrā*	β Orionis
12	*Yad al-Jawzā' al-Yusrā*	γ Orionis
13	*Yad al-Jawzā' al-Yumnā*	α Orionis
14	*Rijl al-Jawzā' al-Yumnā*	κ Orionis
15	*Shiᶜrā Yamānī*	α Canis Majoris
16	*Shiᶜrā Shāmī*	α Canis Minoris
17	*Minkhar al-Shujᶜa*	σ Hydrae
18	*Rās al-Asad*	ε Leonis

	Star Name	Identification
19	*Qalb al-Asad*	α Leonis
20	*Ẓahr al-Dubb al-Akbar*	α Ursae Majoris
21	*Fard al-Shujā*ᶜ	α Hydrae
22	*Ẓahr al-Asad*	δ Leonis
23	*Qā*ᶜ*idat al-Bāṭiya*	α Crateris
24	*Ṣarfa*	β Leonis
25	ᶜ*Anāq*	ζ Ursae Majoris
26	*Janāḥ al Ghurāb*	γ Corvi
27	*Simāk al-A*ᶜ*zal*	α Virginis
28	*Simāk al-Rāmiḥ*	α Bootis
29	ᶜ*Unuq al-Ḥayyah*	α Serpentis
30	*Kiffa Shamālī*	β Librae
31	*Rās al-Jāthī*	α Herculis
32	*Rukbat al-Ḥawwa’ al-Yusrā*	ζ Ophiuchi
33	*Rās al-Ḥawwā’*	α Ophiuchi
34	*Yad al-Ḥawwā al-Yumnā al-Muqaddam*	δ Ophiuchi
35	*Nasr al-Wāqi*ᶜ	α Lyrae
36	*Minqār al-Dajaja*	β Cygni
37	*Nasr al-Ṭā’ir*	α Aquilae
38	*Dhanab al-Dajāja*	α Cygni
39	*Dhanab al-Dulf īn*	ε Delphini
40	*Fam al-Faras*	ε Pegasi
41	*Dhanab al-Jadī*	δ Capricorni

	Star Name	Identification
42	*Sāq Sakib al-Mā' al-Janubī*	δ Aquarii
43	*Dhanab al-Qayṭus Shamālī*	ι Ceti
44	*Mankib al-Faras*	β Pegasi
45	*Sirrat al-Faras*	δ Pegasi / α Andromedae
46	*Kaff al-Khadīb*	β Cassiopeiae

PLATES

There are five plates with the following specifications. The durations given for the longest day are often erratic.

Table A024-2 Plates

	φ	Longest Day
1a	20°	13 hours
1b	36°	14 hours !
2a	25°	13;25 hours
2b	30°	13;18 hours !
3a	27°	13;46 hours
3b	32°	14;8 hours
4a	34°	14;16 hours
4b	42°	15;2 hours
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

On the plates 1-4, altitude circles are drawn for every degree, with each fifth circle dotted. Azimuth arcs drawn below the horizon at intervals of 5° on all plates with the

exception of 4b for the latitude 42^0, where these are drawn above the horizon at the same intervals. In the lower half of the plates are drawn plain lines for seasonal hours and dotted lines for equal hours. On some plates, lines for equal hours are drawn from the western horizon and on some others both from the eastern and western horizons.

On the tablet of ecliptic coordinates, latitude circles are drawn for each degree and alternate circles are numbered. The azimuth or longitude circles are drawn for every 5 degrees and numbered separately in each sign. Along the ecliptic circle the names of the zodiac signs are inscribed in long strokes anti-clockwise. However, the name of the plate *mīzān al-ᶜankabūt* is not engraved.

On the tablet of horizons are drawn half horizons for each degree of latitude from 4 to 65 degrees. Declination scales are engraved along the diameters. The scales are numbered in units of 5 up to 23;30 which is the obliquity. Here also the name of the plate *ṣafīḥa āfāqiyya* is not written.

Figure A024.3 – Geographical Gazetteer (photo by Mubashir Ul-Haq Abbasi)

GEOGRAPHICAL GAZETTEER

On the inner surface of the mater is engraved a geographical gazetteer containing the names of the following 120 localities with their longitudes and latitudes in four circles, in a spiral formation. The localities are arranged according to climates with appropriate headings engraved between the circular rows.[275]

[275] In his astrolabe of 1667 (A087), Muqīm's nephew Ḍiyā' al-Dīn engraves exactly the same gazetteer, but with an addition of four place names at the end.

Table A024-3 Geographical Gazetteer

	Place Name (*al-bilād*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)
	First Circle		
[-I] *az khaṭṭ istiwā tā iqlīm awwal* (from the Equator to the First Climate)			
01	Sāḥil Baḥr Awqiyānūs	11;00	0;0
02	Jazīra Qanbala	21;0	3;0
03	Jamkūt	177;0	5;0
04	Shila	180;0	5;0
05	Kuku	54;10	10;0
06	ᶜAdan	76;0	11;00
[1] *iqlīm awwal* (the First Climate)			
07	Jabal	75;0	13;30
08	Dammār	77;15	13;30
09	Bajja az Barbar	10;5	14;0
10	Zabayd	74;20	14;10
11	Ṣanaᶜān dār Mulk Yaman	77;0	14;30
12	Janad	75;30	14;30
13	Sawmnāt	107;0	17;0
14	Zatūn	114;0	17;15
15	Panjāpūr	105;30	17;20
16	Burhānpūr	108;0	20;30
17	Dawlatābād	111;0	20;30
[II] *iqlīm dūyum* (the Second Climate)			

	Place Name (*al-bilād*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)
18	Jadda	76;0	21;0
19	Ṭāᶜif	77;30	21;20
20	Makka Mubārak	77;10	21;40
21	Kanbayāt	109;20	22;20
22	Khaybar	75;20	24;20
23	Madīnaat Ṭayyiba	75;20	25;00
24	Hurmūz	92;0	25;00
25	Ajmīr	110;5	26;0
26	Kawāliyar	114;0	26;29
27	Lakhnawtī	114;18	26;30
28	Qannawj	105;50	26;35
29	Jawnpūr	119;6	26;26
30	Akbarābad dār al-Khilāfat	115;0	26;43
31	Kūbāmaū	116;38	26;45
32	Mānikpūr Garh	115;10	26;49
33	Awadh	118;6	27;22
34	Badā'ūn	115;14	27;40
[III] *iqlīm siwum* (the Third Climate)			
35	Bakar	105;0	27;40
36	Kūlkandah	114;20	28;4
37	Kūl [wa] Jalālī	114;19	28;4
38	Fīrūzābād	87;30	28;10
39	Sulṭānkūt	115;0	28;30

	Place Name (***al-bilād***)	**L** (***al-ṭūl***)	**φ** (***al-ᶜarḍ***)
40	Dihlī dār al-Mulk al-Hind	103;35	28;39
41	Baran	114;0	28;48
42	Pānīpat	113;20	28;52
43	Shīrāz	88;0	29;36
44	Multān	107;35	29;40
45	Hansī	112;25	29;45
46	Baṣra	84;0	30;0
47	Kirmān	91;30	30;5
	Second Circle		
[III] *tatimma iqlīm siwum* (continuation of the Third Climate)			
48	Tānīsar	112;38	30;10
49	Iskandariyya	61;54	30;18
50	Miṣr	63;20	30;20
51	Sunām	112;25	30;30
52	Parshūr	85;55	31;0
53	Kūfa	79;30	31;30
54	Bayt al-Maqdis	66;30	31;50
55	Lāhūr dār al-Salṭanat	109;20	31;50
56	Yazd	89;0	32;0
57	Iṣfahān	87;40	32;25
58	Farmal	104;35	32;55
59	Qandahār	107;40	33;0

	Place Name (*al-bilād*)	L (*al-ṭūl*)	φ (*al-ʿarḍ*)
60	Siālkūt	109;0	33;0
61	Madā'īn	72;0	33;15
62	Dimashq	70;0	33;15
63	Maymand	101;55	33;20
64	Baghdād	82;0	33;25
[IV] *iqlīm chahārum*			
65	Ṭarābulus	69;40	34;0
66	ʿĀna	76;0	34;0
67	Kāshān	86;0	34;0
68	Mawṣil	77;0	34;30
69	Tūn	92;30	34;30
70	Harāt	94;30	34;30
71	Kābul	104;40	34;30
72	Qumm	85;40	34;45
73	Rayy	86;20	35;0
74	Sāwah	85;0	35;0
75	Kashmīr	108;0	35;0
76	Hamadān	83;0	35;10
77	Ḥalab	72;10	35;50
78	Mashhad	92;30	36;0
79	Suhraward	88;20	36;0
80	Sabzawar	91;30	36;5
81	Basṭām	89;30	36;10

	Place Name (*al-bilād*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)
82	Balkh	101;0	36;11
	Third Circle		
(IV) *tatimma iqlīm chahārum* (continuation of the Fourth Climate)			
83	Tāliqān	85;45	36;10
84	Abhar	84;30	36;45
85	Astarābād	89;35	36;50
86	Qazwīn	85;0	35;55
87	Badakhshān	84;24	37;10
88	Marāgha	82;0	37;20
89	Sarakhs	94;30	37;30
90	Marw	97;0	37;40
91	Tabrīz	82;0	38;0
92	Ardabil	80;30	38;0
93	Nawshahr	78;20	38;10
94	Nakhjawān	8;15	38;40
[V] *iqlīm panjum*			
95	Bākuya	84;30	39;30
96	Samarqand	99;16	39;37
97	Bukhārā	97;30	39;50
98	Tubbat	110;0	40;0
99	Bardaᶜa	83;0	40;30
100	Shamākhī	84;30	40;50
101	Qūniya	66;30	41;0

	Place Name (*al-bilād*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)
102	Khujand	105;35	41;55
103	Khutan	107;0	42;0
104	Kāshān	81;35	42;0
105	Farghāna	102;0	42;20
	Fourth Circle		
[VI] *iqlīm shashum* (the Sixth Circle)			
106	Kāshghar	106;30	44;0
107	Bandaqiya	92;0	44;0
108	Shalkh	100;30	44;0
109	Ṭarāz	99;50	44;31
110	Bīsh Bāligh	110;0	45;50
111	Qarāqūrūm	115;0	46;0
112	Khān Bāligh	124;0	46;0
113	Harqala	67;20	46;30
[VII] *iqlīm haftum* (the Seventh Climate)			
114	Araq	100;0	48;0
115	Bulghār	90;0	49;30
116	Aqchā Kirmān	62;0	50;0
117	Qirqir	65;30	50;0
[VII+] *khāriz az iqlīm haftum* (beyond the Seventh Climate)			
118	Mārī Kirmān	65;45	50;40
119	Jazā'ir Rūdjard	68;50	62;0
120	Ṣūdāq	65;5	51;0

BACK

On the back, the rim of the upper half carries two altitude scales divided in 1° and 5° and numbered as 5—90; 90—5. The upper left quadrant contains the sine-cosine graph with 60 horizontal and 60 vertical parallel lines, where every fifth line is highlighted with dots.

In upper right quadrant are drawn 60 declination circles, one for every 3° of solar longitude; the names of the related zodiac signs are written along the two radii. Each sign is divided into ten parts of 3 degrees each and every alternate division is numbered.

In this quadrant two sigmoid curves for the midday altitude of the sun are drawn for the latitudes of 27° and 32° with the labels *khaṭṭ nisf al-nahār bi-ᶜarḍ 27* and *khaṭṭ nisf al-nahār bi-ᶜarḍ 32.*

Figure A024.4 – Back of the astrolabe (photo by Mubashir Ul-Haq Abbasi)

In the lower half are drawn the shadow squares, on the left for a base of 12 and on the right for a base of 7. The vertical and horizontal scales are divided and numbered accordingly. On the two lower corners there is a label each reading *ẓill sullam,* 'the scale of shadows'. The 4 scales are accompanied by the following labels:

Vertical scale on the left: *ẓill aṣābi^c ma^{c}kūs*

Horizontal scale on the left: *ẓill aṣābi^c mustawī*

Horizontal scale on the right: *ẓill aqdām mustawī*

Vertical scale on the right: *ẓill aqdām ma^{c}kūs.*

Within the shadow squares, there are five semi-circular rows. In the first or the outermost row are the names of the 12 signs of the zodiac; in the next row are the names of the 28 corresponding lunar mansions. Again rows 1, 3, 4, 5 form a table of trigons or triplicities with their regents. In other astrolabes, the regents of the day and the regents of the night are shown separately. Here they are in the same column; the first and the third row show the sign and the day regent, while the next two rows mention the sign and the night regent. Thus Aries has the sun as the regent in the daytime and Jupiter as the regent at night. The table is reproduced below, omitting row 2 with the names of the lunar mansions.

Table A024-4 Triplicities

Aries	Taurus	Gemini		Cancer	Leo	Virgo
Sun	Jupiter	Saturn		Venus	Moon	Mars
Aries	Leo	Sagittarius		Taurus	Virgo	Capricorn
Jupiter	Sun	Saturn		Moon	Venus	Mars
Fiery (*nārī*)				Earthy (*tarabī*)		
Libra	Scorpio	Sagittarius		Capricorn	Aquarius	Pisces
Saturn	Mercury	Jupiter		Venus	Mercury	Moon
Gemini	Libra	Aquarius		Cancer	Scorpio	Pisces
Mercury	Saturn	Jupiter		Mars	Venus	Moon
Airy (*hawā’ī*)				Watery (*mā’ī*)		

Inside these semi-circular tables, immediately below the horizontal diameter, is a table consisting of 3 columns and 8 rows, with the title *mubādī aqālīm sab^{c}a* (beginnings of the seven climates). Strangely, the last row is engraved outside the table as an afterthought.

Table A024-5 Climates

Climates (*aqālīm*)	**Latitudes (*ᶜarūḍ*)**	**Hours (*sāᶜāt*)**
First (*awwal*)	12;48	12;45
Second (*thānī*)	20;31	13;15
Third (*thālith*)	27;34	13;45
Fourth (*rābiᶜ*)	33;43	14;15
Fifth (*khāmis*)	39;1	14;45
Sixth (*sādis*)	43;30	15;15
Seventh (*sābiᶜ*)	47;38	15;45
End *(intihā)* [of the seventh climate]	50;31	16;15

On the rim of the lower half are two cotangent scales, on the left in digits and on the right in feet, corresponding to the shadow scales. The unequal divisions in these scales have numbers written from the centre to either side as 5, 10, 15, and so on up to 90.

Below the cotangent scales there are two astrological tables engraved in five concentric semi-circular rows. The first three rows constitute the table of limits (*ḥudūd*). The second row, together with the fourth and fifth rows, forms the table of decans (*wujūh*) and their regents.

Alidade

The alidade is plain and without any scale. It is clearly a late replacement. But the washer, pin and the horse are original. The mane of the horse, the head and the eyes are nicely engraved.

Inscription

Below the shadow squares, there is an inscription engraved along the inner boundary of the semi-circular table:

ṣan^c^at aḍa^c^f al-^c^ibād muḥammad muqīm ibn ^c^īsā ibn allāhdād asṭurlabī humāyunī lāhorī fī san 1047 hijrī

'Made by the weakest of the creatures [of God] Muḥammad Muqīm, son of ^c^Īsā, son of Allāhdād of Lahore, the astrolabe maker of [the Emperor] Humāyūn, in the year 1047 Hijrī.'

On either side of the shadow squares are engraved two other dates 'in 1007 year Yazdegirdī' and 'in 1949 year Rūmī'. The Yazdegirdī year 1007 is from 18 October 1637 to 17 October 1638. The Rūmī (i.e. Syro-Macedonian era) year 1949 is from 11 October 1637 to 10 October 1638. The Hijrī year 1047 is from 27 May 1637 to 14 May 1638. Therefore, this astrolabe was completed sometime between 18 October 1637 and 27 May 1638.

A025⊙ ASTROLABE BY MUḤAMMAD MUQĪM, AH 1047 (AD 1637-38)

Diameter 205 mm

New Delhi, Archaeological Museum, Red Fort (Reg. No. 40.421, Acc. No. 65.)

CCA 3721; Répertoire 10

Figure A025.1 – Front of the astrolabe (photo courtesy A. J. Turner)

COMPONENTS

Body with *kursī* (d. 205, h. 254, t. 9), rete (d. 189) for 44 stars, 5 plates (d. 189), alidade (187 x 14). The finial of the *kursī* is broken off and the ring and the shackle are lost. In the absence of the finial, the exact height cannot be determined.

FRONT

The *kursī* is elegantly reticulated; its profiles are made up of the flared petals of two tulips on each side; between these two, there is a third tulip placed in the reverse direction.

The limb is divided in 1° and 5° and labelled from 5 to 360.

RETE

The two rings of Capricorn and ecliptic are held together by the equinoctial bar with two counter changes at its two intersections with the ecliptic circle. The ecliptic circle is divided in 12 signs of zodiac and labelled with their names. Each sign is subdivided into units of 6° and numbered accordingly. Each of these is further subdivided into units of 2° and marked on the sloping edge of the ecliptic circle.

The star pointers are joined by a floriated tracery where the motif of tulips with flared petals reoccurs. There are about 44 star pointers.[276]

There is a handle to the left of the north point on the Capricorn ring.

Table A025-1 Stars on the Rete

	Star Name	Identification
01	*Dhanab Qayṭus J[anūbī]*	β Ceti
02	*Baṭn Ḥūt*	β Andromedae
03	*Rijl Musalsalah*	γ Andromedae
04	*Fam Qayṭus*	γ Ceti
05	*Ṣadr Qayṭus*	π Ceti

276 A selection of the star list is given in Sen 1990, p. 122.

	Star Name	Identification
06	*Ghūl*	β Persei
07	*Kaff Jadhmā'*	α Ceti
08	*Tālī Masāfat al-Nahr*	γ Eridani
09	*Dabarān*	α Tauri
10	^{c}*Ayyūq*	α Aurigae
11	*Rijl Jawjā' Yusrā*	β Orionis
12	*Yad Yusrā*	γ Orionis
13	*Yad Yumnā*	α Orionis
14	*Rijl Yumnā*	κ Orionis
15	^{c}*Abūr*[277]	α Canis Majoris
16	*Ghumayṣā'*[278]	α Canis Minoris
17	*Fard Shujā*^{c}	α Hydrae
18	*Rās Asad*	μ Leonis
19	*Ẓahr Dubb Akbar*	α Ursae Majoris
20	*Qā*^{c}*idat Bāṭiya*	α Crateris
21	*Ẓahr Asad*	δ Leonis
22	*Ṣarfa*	β Leonis
24	*Janāḥ Ghurāb*	γ Corvi
25	*Simāk A*^{c}*zal*	α Virginis
23	^{c}*Anāq*	ξ Ursae Majoris

277 The engraving reads ^{c}*anūr,* but it must be an error for ^{c}*abūr,* another Arabic designation for Sirius; cf. Kunitzsch 1959, p. 73: 'Etymon arab. *al-*^{c}*abur,* Beiwort des Namens des Sirius: *aš-ši*^{c}*rā al-*^{c}*abūr* "S., der (die Milchstrasse) überquert hat)…'

278 Another Arabic name for Procyon; cf. Kunitzsch 1959, p. 74: 'Auf orientalistischen Instrumenten ebenso wie in Europa auch nur kurz *al-ġumayṣā'* genannt;…'

	Star Name	Identification
26	*Simāk Rāmiḥ*	α Bootis
27	*Kiffa Shamālī*	β Librae
28	*Munīr [min] Fakkah*[279]	α Coronae Borealis
29	*ᶜUnuq Ḥayyah*	α Serpentis
30	*Rukbat al-Ḥawwā' al-Yusrā*	ρ Ophiuchi
31	*Jāthī*	α Herculis
32	*Rās Ḥawwā'*	α Ophiuchi
33	*Waqiᶜ*	α Lyrae
34	*Minqār Dajāja*	β Cygni
35	*Ṭā'ir*	α Aquilae
36	*Dūlfīn*	ε Delphini
37	*Ridf*	α Cygni
38	*Dhanab al-Jadī*	δ Capricorni
39	*Fam Faras*	ε Pegasi
40	*Sāq Sākib al-Mā'*	δ Aquarii
41	*Mankib al-Faras*	β Pegasi
42	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
43	*Surrat al-Faras*[280]	δ Pegasi
44	*Khaḍīb*	β Cassiopeiae

279 Instead of the common designation *nayyir al-fakka,* the astrolabist employs a designation used by al-Ṣūfī; cf. Savage-Smith 1985, p. 142: 'Al-Ṣūfī (*Ṣuwar*, 57) also calls it *al-munīr min al-fakkah.*'

280 The two designations *Surrat al-Faras* (δ Peg, no. 43 here) and *Rijl Musalsala* (γ And, no. 3 here) pertain to one and the same star, but here two stars are shown separately; cf. Savage-Smith 1985, pp. 158, 160.

Star Name	Identification

PLATES

There are 5 plates with following specifications:

Table A025-2 Plates

	φ	Longest Day
1a	21°	13;21 hours
1b	24	13;22 hours
2a	27°	13;46 hours
2b	32°	14;8 hours
3a	36°	14;32 hours
3b	40°	14;52 hours
4a	0° +90°	
4b	36° + 42°	
5a	Tablet of ecliptic coordinates	
5a	Tablet of horizons	

On plates 1-4, altitude circles are drawn for every 2° and every fifth is highlighted with dots; azimuth circles are drawn for every 10° below the horizon, occasionally also above or both above and below the horizon. There are lines for seasonal hours and lines drawn from the western horizon for equal hours; sometimes these lines for equal hours are drawn from the western horizon and also from the eastern horizon up to the meridian. East and west points on the horizon are labelled with *al-mashriq* and *al-maghrib*.

GEOGRAPHICAL GAZETTEER

There is a gazetteer arranged in spiral form in four annular circles (48 + 36 + 24 + 12 -4) = 116 localities.

BACK

The rim of the two upper quadrants carries the altitude scales, which are divided in 1° and 5° and labelled 5—90; 90—5. The rim of the lower half bears the cotangent scale.

The The trigonometric quadrant in the upper left is engraved with 60 horizontal and 60 vertical parallels, where each fifth line is highlighted with dots. In the upper right quadrant are 30 declination arcs for each 6° of solar longitude; along the two radii are marked the names of the signs and their divisions. On this quadrant are drawn two solar meridian altitude graphs for the latitudes of 27° and 32° with the labels *khaṭṭ niṣf al-nahār bi- ᶜarḍ 27* and *khaṭṭ niṣf al-nahār bi- ᶜarḍ 32.*

In the lower half are drawn the shadow squares, on the left for the base of 12 digits and on the right for the base of 7 feet. The vertical and horizontal scales related to the shadow squares are divided and numbered accordingly and carry the following labels.

Vertical scale on the left:	*ẓill aṣābiᶜ maᶜkūs*	(reverse shadow in digits)
Horizontal scale on the left:	*ẓill aṣabiᶜ mustawī*	(direct shadow in digits)
Horizontal scale on the right:	*ẓill aqdām mustawī*	(direct show in feet)
Vertical scale on the right:	*ẓill aqdām maᶜkūs*	(reverse shadow in feet)

In the two inner corners of the squares is written *ẓill sullam* (scale of shadows)

Inside the shadow squares, there are six semi-circular rows. In the first two are engraved the names of the lunar mansions and the names of the corresponding signs respectively. The next two rows contain the table of limits (*ḥudūd*) and the last two rows the decans and their regents (*wujūh*).

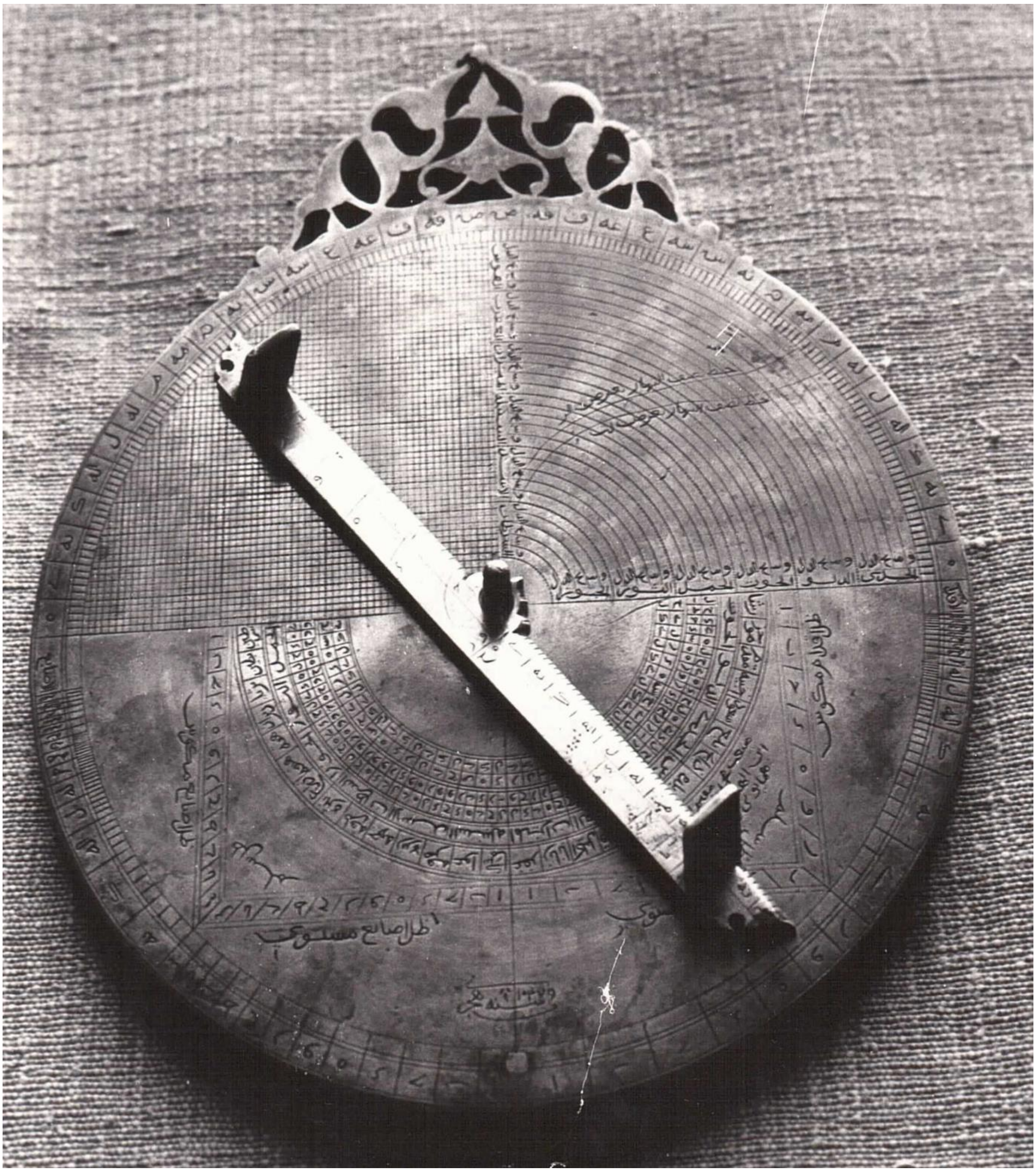

Figure A025.2 – Back of the astrolabe (photo courtesy A. J. Turner)

ALIDADE

Straight bar alidade with ornate ends (crab-claw variety) and ornate centre-piece; it bears a zodiacal scale on one side and a sexagesimal scale and universal hour scale on the other.

Figure A025.3 – Signature of the astrolabe maker (photo by S. R. Sarma)

INSCRIPTION

In the space between the shadow squares and the semi-circular tables, in the right hand side corner, is engraved the signature of the maker in three lines, as follows:

ṣan

ṣan[c]at muḥammad muqīm ibn [c]īsā
ibn allāhdād asṭurlābī
humāyūnī lāhūrī

and a fourth line is engraved below the shadow squares, on the meridian line just above the cotangent scale:

fī sanah 1047 hijrī

‘The work of Muḥammad Muqīm, son of [c]Īsā,
son of Allāhdād of Lahore, the astrolabe maker to
[the Emperor] Humāyūn,
in the year 1047 of Hijrā.’

BIBLIOGRAPHY

Behari & Govind 1980, p. 101-2, no. 8.
Sen 1990, p. 122: a selection of the stars.

A026⊙ ZOOMORPHIC ASTROLABE BY MUḤAMMAD MUQĪM, AH 1047 (AD 1637)

Diameter 258 mm

Hyderabad, Salar Jung Museum (#114/1/xxxv)

CCA-nil

Figure A026.1 – Front of the astrolabe (photo by S. R. Sarma)

This astrolabe is a fabulous creation by Muḥammad Muqīm. It may be recalled Allāhdād, the patriarch of the Lahore family, incorporated finely crafted zoomorphic images of the two stars Vega and Altair in the rete of his undated astrolabe (A002). In the present fabulous astrolabe, his grandson Muqīm playfully gave zoomorphic and anthropomorphic shapes to 29 star pointers in the rete.[281] Playful also is the arrangement of the geographical gazetteer which begins in the inner circle and continues up to the outer circle.

COMPONENTS

Body with *kursī* (d. 258, h. 327, t. 12), shackle and ring, rete (d. 238) for 45 stars, 4 plates (d. 238). One of the plates is completely blank on both sides and is a replacement. The alidade with a sighting tube, bolt and nut are also replacements.

FRONT

The astrolabe is suspended by a large ring with a diamond-shaped cross section. To this is attached a small shackle; its upper part also has diamond-shaped cross-section, and the lower part is riveted to the top of the *kursī*.

The *kursī* is high and is intricately pierced with several interlinking triangles and vines. The *kursī* terminates in a trefoil design. Both sides of the surface of the fretwork of the *kursī* display leaves and tendrils in shallow engraving with a slightly different colouration, which was achieved by closely drawn crisscross lines.[282]

The scale on the limb is divided in 1° and in 5° and numbered in 5s from 5 to 360 clockwise from the south point.

RETE

The two rings of the Tropic of Capricorn and the ecliptic are held together by the equinoctial bar which is counter-changed at the two equinoxes. The upper edge of the middle segment of the bar represents the equinoctial colure. The ecliptic circle is divided

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281 He made a still grander version but neglected to add his signature in that astrolabe (see A051 below); his son Jamāl al-Dīn also produced a zoomorphic astrolabe in 1666 (A121). On zoomorphic astrolabes, see Gingerich 1987a.

282 Such surface ornamentation can be seen also in the *kursī* of the astrolabe Muqīm made in 1643 (A030) which will be described below; cf. Gunther 1932, vol. I, Pl. XLVII, p. 199.

into the 12 signs and labelled with their names. Each sign is further subdivided into groups of 5° and in single degrees. Like the other productions of Muqīm, this rete too exhibits an intricate floral pattern, with circular loops of vines, tendrils, leaves, buds and flowers.

More important still is the fact that of the 45 star pointers as many as 29 pointers display the zoomorphic or anthropomorphic shapes of the respective constellations as conceived in the Hellenistic or Bedouin traditions. Here Muqīm cut the outline of the desired shape as a silhouette and engraved on it the appropriate lines for the eyes, mouth and so on.

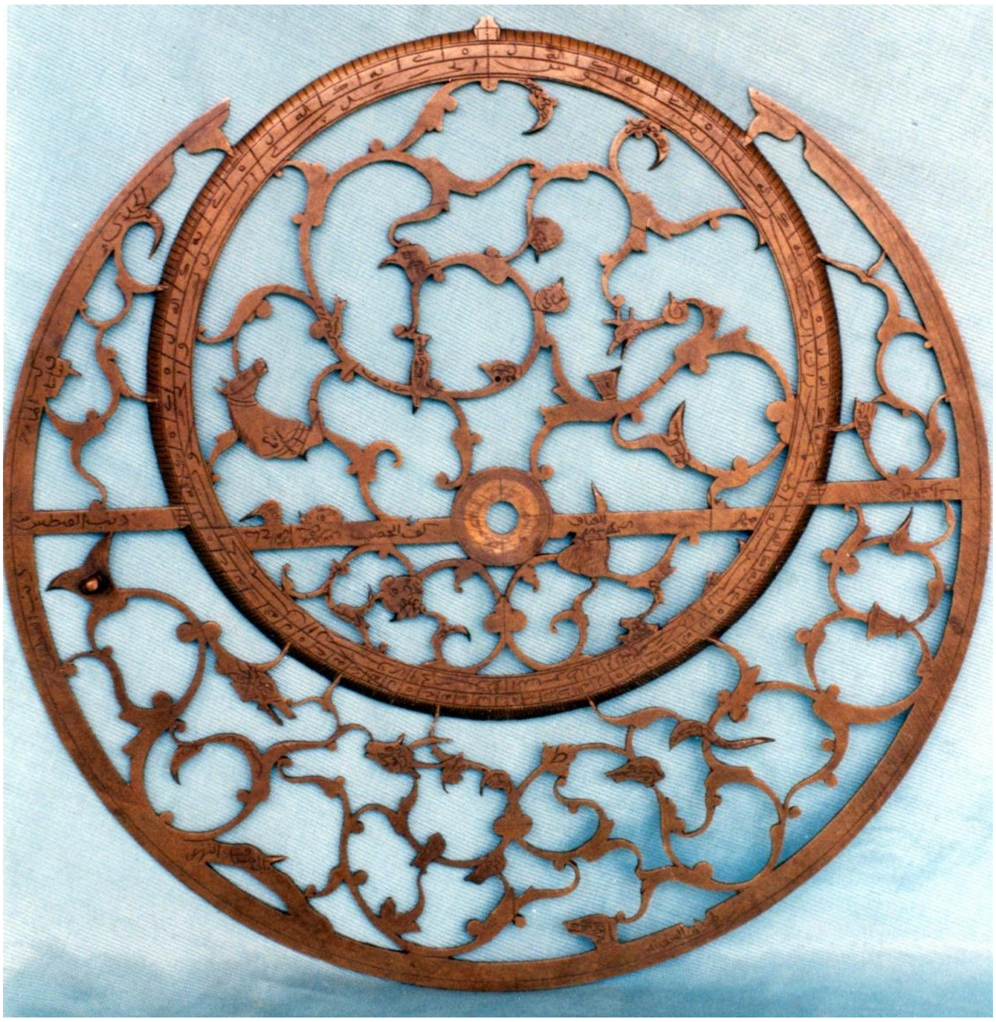

Figure A026.2 – Zoomorphic Rete (photo by S. R. Sarma)

Table A026-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus J[anūbī]*	β Ceti

	Star Name	Identification
2	*Baṭn al-Ḥūt*	β Andromedae
3	*Rijl al-Musalsala*	γ Andromedae
4	*Fam al-Qayṭus*	γ Ceti
5	*Ṣadr al-Qayṭus*	π Ceti
6	*Ghūl*	β Persei
7	*Tālī Masāfat al-Nahar*	γ Eridani
8	*ᶜAyn al-Thawr*	α Tauri
9	*ᶜAyyūq*	α Aurigae
10	*Rijl Yusrā*	β Orionis
11	*Yad Yusrā*	γ Orionis
12	*Yad Yumnā*	α Orionis
13	*Rijl Yumnā*	κ Orionis
14	*Shiᶜrā Yamānī*	α Canis Majoris
15	*Shiᶜrā Shāmī*	α Canis Minoris
16	*Ṭarfat al-Safīna*	ρ Puppis
17	*Minkhar al-Shujāᶜ*	σ Hydrae
18	*Fard al-Shujāᶜ*	α Hydrae
19	*Rās al-Asad Shamālī*	μ Leonis
20	*Ẓahr Dubb Akbar*	α Ursae Majoris
21	*Qāᶜidat al-Bāṭiya*	α Crateris
22	*Ẓahr [al-Asad]*	δ Leonis
23	*Ṣarfa*	β Leonis
24	*Janāḥ al-Ghurāb*	γ Corvi
25	*Simāk Aᶜzal*	α Virginis

	Star Name	Identification
26	*Al-ᶜAnāq*	ξ Ursae Majoris
27	*Simāk Rāmiḥ*	α Bootis
28	*Fakka*	α Coronae Borealis
29	*ᶜUnuq al-Ḥayya*	α Serpentis
30	*Rakbat Ḥawwā' al-Yusrā*	ρ Ophiuchi
31	*Al-Jāthī*	α Herculis
32	*Al-Ḥawwā'*	α Ophiuchi
33	*Yad Ḥawwā' Yumnā Muqaddam*	δ Ophiuchi
34	*Al-Wāqiᶜ*	α Lyrae
35	*Minqār al-Dajāja*	β Cygni
36	*Al-Ṭā'ir*	α Aquilae
37	*Dhanab Dālfīn*!	ε Delphini
38	*Ridf*	α Cygni
39	*Dhanab al-Jadī*	δ Capricorni
40	*Sāq-i Sākib al-Mā' J[anūbiya]*	δ Aquarii
41	*Mankib al-Faras*	β Pegasi
42	*Surrat al-Faras*	δ Pegasi
43	*Janāḥ al-Faras*	γ Pegasi
44	*Dhanab al-Qaytus Sh[amālī]*	ι Ceti
45	*Kaff al-Khaḍīb*	β Cassiopeiae

The zoomorphic shapes of the 29 star pointers will be listed below and shown how they were pictorially depicted. For each star, we shall provide first the Arabic name of

the star as engraved on the astrolabe and its literal meaning and then show how Muqīm lends a visual form to this meaning.

The first major constellation south of the ecliptic is the sea-monster Cetus, transliterated as *al-Qayṭus* in Arabic. The Greeks thought of it as a whale, but in the Islamic world, it assumed a more fantastic shape with ‘a snarling dog’s head, bird’s feet, and a feathered fish tail’.[283] Such a shape is drawn fully on Mughal globes.[284] But the full form cannot be shown on the rete of the astrolabe. Therefore, Muqīm just depicts the fish tail with the two fins (northern and southern) and the dog’s head, placing the appropriate stars in these parts. The tips of the tail fins become the pointers to the stars called respectively after these. At the intersection of these two tail fins, there is also a handle to rotate the rete.

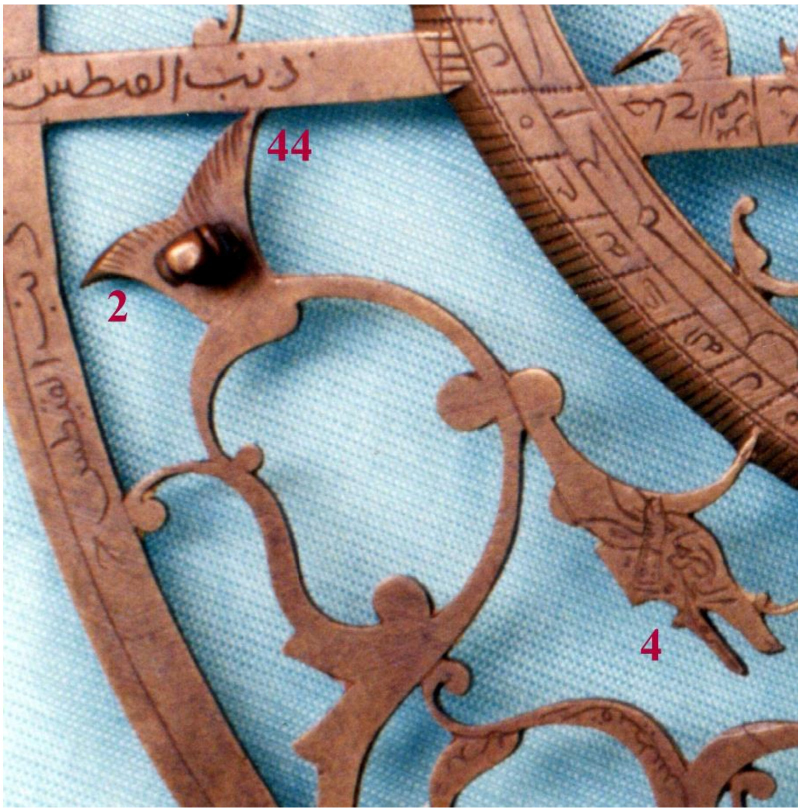

Figure A026.3 – Detail of Figure A026.2. The constellation Cetus with the stars β Ceti (2), ι Ceti (44) and γ Ceti (4).

283 Savage-Smith 1985, p. 187.

284 Savage-Smith 1985, p. 188, fig. 75; Sarma 2015a, p. 273, fig. 19.8.

1. *Dhanab al-Qayṭus J[anūbī]* (southern tail of Cetus), shown as the tip of the southern fin of the fish tail.

4. *Fam al-Qayṭus* (mouth of Cetus), snarling dog's head

6. *Ghūl* (actually *Rās al-Ghūl,* 'head of the ghoul'), demon's head with horns.

7. *Talī Masāfat al-Nahr* (valley or expanse of the river [Eridanus], the river is shown as an arc, from which projects the thin star pointer.

8. ^{c}*Ayn al-Thawr* (eye of the bull), a well-executed head of a bull with slender horns and an engraved eye.

10-11-12-13. The next four stars depict the two hands and the two feet of Orion. The hands are skillfully represented: the three last fingers are folded, and the index finger outstretched to form the star pointer. The feet are depicted through tapering shoes.

14. *Shi*^{c}*rā Yamānī* (the southern Shi^{c}ra, α Canis Majoris, Sirius), dog's head.

15. *Shi*^{c}*rā Shāmī* (the northern Shi^{c}ra, α Canis Minoris, Procyon), dog's head.

17. *Minkhar al-Shujā*^{c} (the nose of the serpent), snake's head.

19. *Rās al-Asad Shamālī* (the northern head of the lion), lion's head.

20. *Ẓahr Dubb Akbar* (back of the Great Bear), outline of the grizzly or serrated back of the bear.

21. *Qā'idat al-Bāṭiyā* (bottom of the cup), a bucket with vertical serrations.

24. *Janāḥ al-Ghurrāb* (wing of the raven), pointed stylized wing.

25. *Simāk A*^{c}*zal* (α Virginis, Spica), Virgo's hand.

28. *Al-Fakka* (α Coronae Borealis, Alphecca), crown, more like a bucket.

29. ^{c}*Unuq al-Ḥayya* (neck of the serpent), open mouthed snake's head.

31. *Al-Jāthī* (actually *Rās al-Jāthī,* the head of the kneeling man, i.e. Herculus), a human face.

32. *Al-Ḥawwā'* (actually *Rās al-Ḥawwā'*, the head of the serpent charmer) a human face.

34. *Al-Wāqi*^{c} (actually *al-Nasr al-Wāqi*^{c}, the falling eagle), bird's beak.

35. *Minqār al-Dajāja* (the bird's beak), chicken.

36. *Al-Ṭā'ir* (short for *al-Nasr al-Ṭā'ir*, the flying eagle), eagle's head with a curved beak and an engraved eye.

39. *Dhanab al-Jadī* (tail of the goat), tail.

41. *Mankib al-Faras* (shoulder of the horse), horse's head and shoulder, excellently executed and engraved.

42. *Surrat al-Faras* (the navel of the horse, δ Pegasi = α Andromedae). This star is common to the two constellations Pegasus and Andromeda. Here it is named after Pegasus but represented with Andromeda's face with demure eyes.

43. *Janāḥ al-Faras* (wing of the horse), a stylized wing.

44. *Dhanab al-Qayṭus Sh[amālī],* (northern tail of Cetus), shown as the tip of the northern fin of the fish tail.

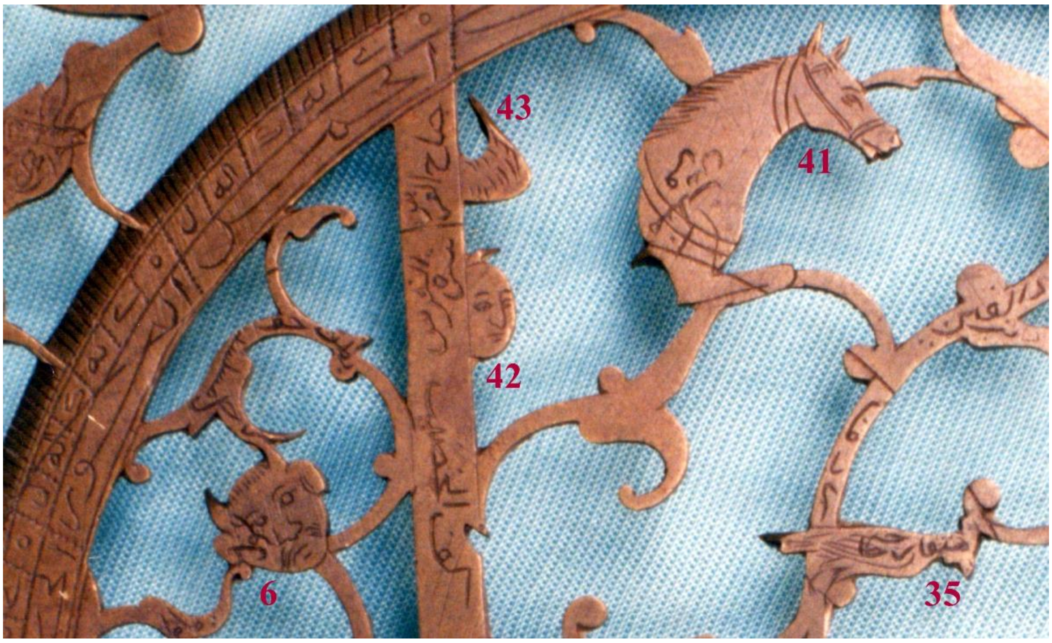

Figure A026.4 – Detail of Figure A026.2. Here can be seen two anthropomorphic and three zoomorphic images together with their names: β Persei (6: *Ghūl*), α Andromedae (42: *Surrat al-faras*), γ Pegasi (43: *Janāḥ al-faras*), β Pegasi (41: *mankib al-faras*) and β Cygni (35: *Miqār Dajāja*).

PLATES

There are four plates. One of these is completely blank on both sides and is obviously a replacement for a lost original. The other plates contain equal altitude circles for every single degree. Every second circle is numbered on both the sides and every fifth circle is highlighted with dots. The azimuth curves are drawn below the horizon for each 5°. In addition to the unequal hour lines, some plates have curves for the hours since sunset, others also for the hours before sunrise. Under the western horizon is engraved *al-maghrib* and under the eastern horizon *al-mashriq.* The three inscribed plates serve the following latitudes:

Table A026-2 Plates

	φ	Longest Day
1a	18°	13;9 hours
1b	21°	13;22 hours
2a	23;30°	13;21 hours !
2b	Tablet of ecliptic coordinates	
3a	36°	14;54 hours
3b	39°	14:14 (!) hours

Perhaps the lost plate carried projections for the latitudes 27° and 32°. Perhaps there was also another plate bearing the tablet of horizons.

GEOGRAPHICAL GAZETTEER

On the inner side of the mater is an elaborate gazetteer of 155 towns with their longitudes and latitudes, engraved in five concentric circles which are separated from one another by double lines. The gazetteer does not commence at the south point in the outer circle as in almost all astrolabes, but in the inner circle. Therefore, the data is inscribed upside-down, that is to say, the upper part of the letters are towards the centre and the lower part towards the rim. In each circle to the left of the vertical radius there is the argument in the three successive rows: *al-bilād* (place name), *al-ṭūl* (longitude) and *al-ᶜarḍ* (latitude). The gazetteer is read from the argument onwards from right to left, from the innermost (first) circle to the outermost (fifth) circle. The gazetteer is arranged according to increasing longitudes, although occasionally it goes back and forth.

Figure A026.5 – Geographical gazetteer (photo by S. R. Sarma)

Table A026-3 Geographical Gazetteer

	Place Name	L	φ
	Innermost/First Circle		
001	Qayrawān	41;0	31;30
002	Mahdiyya	42;0	32;30
003	Miṣr	63;20	30;20

	Place Name	L	φ
004	ᶜAdan	76;0	11;0
005	Madīnat Tayyiba	75;20	25;0
006	Makka Musharraf	77;10	21;40
007	Tā’īf	77;30	21;30
008	Bayt al-Maqdis	66;30	31;50
009	Dimashq	70;0	33;15
010	Baᶜalbak	70;45	33;15
011	Ḥimṣ	70;45	34;0
012	Ḥalab	72;10	35;50
013	Ṭarsūs	68;40	36;42
014	Malaṭiya	71;0	37;0
015	Ardhan al-Rūm	77;0	39;40
	Second Circle		
016	Arzinkān	77;0	38;0
017	Sīwās	71;40	39;0
018	Qūnya	66;30	41;0
019	Raqqa	73;15	36;0
020	ᶜĀna	76;30	34;0
021	Mawṣil	77;0	34;30
022	Arjīs	77;0	38;30
023	Salamās	79;15	34;40
024	Khuway	79;40	34;40
025	Awrṣiya ?	79;45	34;0
026	Nakhjawān	81;15	38;40

	Place Name	L	φ
027	Tabrīz	82;0	38;0
028	Ardabīl	82;30	38;0
029	Mūqān	83;0	38;0
030	Bardaᶜa	83;0	40;30
031	Bākūya	84;30	39;30
032	Shamākhī	84;30	40;50
033	Bāb al-Abwāb	85;0	45;0
034	Bulghār	90;0	49;0
035	Kūfa	79;30	31;30
036	Madā'īn	72;0	33;10
037	Baghdād	80;0	33;25
038	Baṣra	84;0	30;0
	Third Circle		
039	Rāmhurmūz	85;45	31;0
040	Arjān	86;30	35;30
041	Fīrūzābād	87;30	28;10
042	Shīrāz	88;0	29;36
043	Iṣtakhr	88;30	30;0
044	Yazd	89;0	32;40
045	Shahrazūr	82;20	32;30
046	Zankān	83;40	36;30
047	Abhar	84;30	36;30
048	Hamadān	83;0	35;10
049	Karaj	84;45	34;0

	Place Name	L	φ
050	Sāwa	85;0	35;0
051	Qazwīn	85;0	36;0
052	Iṣfahān	86;40	32;25
053	Kāshān	86;0	34;0
054	Qumm	85;40	34;45
055	Rayy	86;20	35;0
056	Khuwār	87;10	36;40
057	Ṭāliqān	85;45	36;10
058	Astarābād	89;35	36;50
059	Jarjān	90;0	36;50
060	Samnān	88;0	36;0
061	Damghān	88;55	36;20
062	Busṭām	89;30	36;10
063	Sabzwār	91;30	36;0
064	Nīshābūr	92;30	36;21
065	Mashhad	91;30	34;0
066	Turshīz	91;0	35;0
067	Tūn	92;30	34;0
068	Qā’īn	93;20	33;40
069	Harāt	94;20	34;30
	Fourth Circle		
070	Bādghīs	94;30	35;20
071	Sarakhs	94;30	37;0
072	Marw	94;0	37;40

	Place Name	L	φ
073	Jūrjān	98;0	35;30
074	Fāriyāb	99;0	36;45
075	Balkh	101;0	36;41
076	Bāmiyān	102;0	37;35
077	Samankān	102;0	36;0
078	Qabādhiyān	102;0	37;45
079	Walwālij	102;20	36;55
080	Andarāb	103;45	36;0
081	Badakhshān	104;24	37;10
082	Bulūr	108;0	37;0
083	Hazār Asf	95;0	41;0
084	Darqān	94;15	39;30
085	Bukhārā	97;30	39;50
086	Samarqand	99;16	39;37
087	Nasaf	98;0	39;0
088	Ṭarāz	99;50	44;30
089	Khujand	105;35	41;55
090	Uzkand	102;50	44;0
091	Ush	102;20	43;20
092	Kāshghar	106;30	44;0
093	Jāj	109;0	42;30
094	Khutan	107;0	42;0
095	Al-Māligh	102;30	44;0
096	Bīsh Bāligh	101;0	45;50

	Place Name	L	φ
097	Qarāqūrūm	105;0	46;0
098	Khān Bāligh	124;0	46;0
099	Mahrī	140;0	30;0
100	Hurmūz	92;0	25;0
101	Bardshīr	92;30	29;50
102	Jīruft	93;0	24;30
103	Bamm	94;0	28;30
104	Barmāsīr	94;3	29;0
105	Khabīṣ	93;0	31;0
106	Pust	105;0	33;0
107	Maymand	101;55	33;20
108	Ghaznah	104;20	33;35
	Outer/Fifth Circle		
109	Banjahir	104;40	35;0
110	Ribāṭ Amīr	105;0	34;0
111	Kach Makrān	99;0	28;0
112	Kirmān	91;30	30;5
113	Dabīl	102;30	25;10
114	Bakir	105;0	27;40
115	Nahlawara	102;30	22;0
116	Sawmnāth	106;0	17;0
117	Multān	104;35	29;40
118	Qandahār	109;20	31;50
119	Lāhūr	109;20	31;50

	Place Name	L	φ
120	Qannawj	105;50	26;30
121	Bānāras	107;20	26;55
122	Sarandīb	104;0	10;0
123	Tubbat	110;0	40;0
124	Kasmīr	108;0	35;0
125	Jamkūt	177;0	5;0
126	Shilā	180;0	5;0
127	Jind	75;30	14;30
128	Damār	77;15	13;30
129	Maᶜbar	102;0	17;30
130	Maᶜdan Rami	66;0	21;0
131	Maᶜdan Dhahab	67;35	21;45
132	Khaybar	75;20	24;20
133	Jidda	76;0	21;0
134	Bīrūn	84;30	24;45
135	Kanbāyat	109;20	26;20
136	Dawlatābād	111;0	20;30
137	Kawāliyar	114;0	26;29
138	Lahkanūtī	114;13	26;30
139	Kopāmayū	116;33	25;45
140	Jawnpūr	119;6	26;36
141	Karah wa Mānakpūr	118;10	26;49
142	Ajmīr	111;5	26;0
143	Awadh	118;6	27;22

	Place Name	L	φ
144	Akbarābād	115;0	26;43
145	Farmal	104;35	32;55
146	Sālkot	109;0	33;0
147	Hānsī	112;35	29;45
148	Sanām	112;25	30;30
149	Thānīsar	112;33	30;10
150	Bānībaht	113;20	28;52
151	Ḥaḍrat Dihlī	113;35	28;39
152	Baran	114;0	28;40
153	Kol wa Jalālī	114;19	28;4
154	Burhānpūr	113;0	20;30
155	Pajānpūr	105;30	16;20

Figure A026.6 – Back of the astrolabe (photo by S. R. Sarma)

BACK

On the back, the rim of the upper half carries the two altitude scales which are divided 1° and 5° and numbered in 5s as 5—90; 90—5.

In the upper left is the sexagesimal trigonometric quadrant with 60 horizontal parallels, one for each unit of the Radius. Every fifth line here is dotted. In the upper

right is the solar quadrant with declination circles for each 6° of solar longitude. The corresponding zodiac signs are labelled along the two radii, and groups of 6° are numbered separately for each sign. Upon these declination circles are drawn two sigmoid curves of the solar meridian altitude at the latitudes of 27° (Agra) and 32° (Lahore). There carry the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ 32* respectively.

In the lower half are the shadow squares, on the left for a base of 12 and the right for a base of 7. In the two corners of the squares is the label *ẓill sullam* (shadow scale). The vertical and horizontal scales are divided and numbered. They carry the following brief labels:

Vertical scale on the left: *aṣābiᶜ maᶜkūs* (reverse [shadows] in digits)
Horizontal scale on the left: *aṣābiᶜ mustawī* (direct [shadows] in digits)
Horizontal scale on the right: *aqdām mustawī* (direct [shadows] in feet)
Vertical scale on the right: *aqdām maᶜkūs* (reverse [shadows] in feet).

On the rim of the lower half are the corresponding scales of cotangents. The scale on the left is divided in digits as stated by the label *al-aṣābiᶜ* at the end of the scale. The irregular divisions are numbered as 5, 10, 12, 15, 20, 25, … 90. In the next semi-circular row, these divisions are subdivided into 5 parts.

The scale on the right is divided in feet as stated by the label *al-qadām* at the end of the scale. The irregular divisions are numbered as 5, 7, 10, 15, 20, 25, … 90. In the next semi-circular row, these divisions are subdivided into 5 parts.

Inside the shadow squares are six semi-circular rows containing the following. Rows 1-2 contain the names of the 28 lunar mansions and the names of the 12 corresponding zodiac signs. Rows 2-4 constitute a table of limits (*hudūd*) and rows 2, 5-6 a table of decans (*wujūh*) and their regents. These tables are the same as in A016.

Inside these semi-circular rows, just below the horizontal diameter, are two rectangular tables. The one of the left has the title *faḍl al-dawr* (excess of revolution). It shows the multiples of the difference between the length of the tropical year and 365 days. It is almost the same as in A016, with one minor difference for 6.

Table A026-4 Excess of Revolution

1	87 33	10	155 31

2	175 6	20	61 2
3	262 39	30	106 33
4	350 12	40	262 4
5	77 45	50	57 35
6	165[285] 19	60	213 6
7	252 52	70	08 37
8	340 25	80	164 8
9	67 58	90	319 39

The table on the right is entitled *arbāb muthallathāt laylī wa nahārī* (the regents of the triplicities at night and in the day). It differs in two items from the table in A016.

Table A026-5 Triplicities

Fiery *nārī*				Earthy *tarābī*		
Sun	Jupiter	Saturn		Venus	Moon[286]	Mars
Aries	Leo	Sagittarius		Taurus	Virgo	Capricorn
Jupiter	Sun	Saturn		Moon	Venus	Mars
Airy *hawā'ī*				Watery *mā'ī*		
Saturn	Mercury	Jupiter		Venus	Mars[287]	Moon
Gemini	Libra	Aquarius		Cancer	Scorpio	Pisces
Mercury	Saturn	Jupiter		Mars	Venus	Moon

285 It is 164 in A016.

286 It is Mercury in A016.

287 It is Mercury in A016.

ALIDADE ETC

The original alidade, pin, and horse are missing. These are replaced by a crude sighting tube attached to a straight alidade with a three-lobed central part, a screw and a bolt.

INSCRIPTION

The maker's signature is engraved in two parts, inside the half-circle close to the centre and below the half circle near the rim and reads as follows:

> *ṣan*^{c}*at muḥammad muqīm ibn* ^{c}*īsā ibn allāhdād asṭurlābī humāyūnī lāhūrī fī sanaḥ 1047 ḥijrī.*
>
> 'Made by Muḥammad Muqīm, son of ^{c}Īsa, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the Hijrī year 1047 [= 1637-38 AD].'

BIBLIOGRAPHY

Gingerich 1987a.

Sarma 1996, pp. 11-17, pls. 4-5.

A027 ASTROLABE BY MUḤAMMAD MUQĪM, AH 1038 (AD 1638-39)

Diameter 102 mm

Kolkata, Indian Museum (# 24430)

CCA 3730; Répertoire 11

The Répertoire contains the following information

RETE

The ecliptic is divided into the 12 signs of the zodiac and labelled with their names. The star pointers carry the names of 17 the fixed stars. The Répertoire adds that the rete is incomplete without explaining in what way it is incomplete.

PLATES

Five plates.

BACK

On the back, trigonometric quadrant on the upper left, solar quadrant on the upper right with two curves for the midday altitude of the sun at the latitudes 27° and 32° and shadow squares and astrological tables in the lower half.

INSCRIPTION

The maker's signature reads:

ṣan^c^at muḥammad muqīm ibn ^c^īsā ibn allāhdād asṭurlābī

humāyūnī lāhūrī

fī sanah 1048 hijrī

'Made [by] Muḥammad Muqīm, son of ^c^Īsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn in the year 1048 of Hijrā.'

No other details are available. The museum authorities did not respond to my request for permission to study the astrolabe.

A028⊙ ASTROLABE BY MUḤAMMAD MUQĪM, AH 1051 (AD 1641-42)

Diameter 128 mm

Oxford, Museum of the History of Science (#46935)

CCA 2531; Répertoire 13

Figure A028.1 – Front of the astrolabe (photo by S. R. Sarma)

COMPONENTS

Body with *kursī* (d. 128, h. 160, t. 8), shackle, ring and rope, rete (d. 116) for 39 stars, 4 plates (d. 116), alidade, pin and horse. The alidade is plain and maybe a replacement. The horse is extravagantly long. There is space for one more plate; maybe one is missing.

FRONT

The rope (*ilāqa*) is made of white, cream and blue threads. The ring has an oval cross-section; the ends are not soldered together, it is not even very circular; maybe a replacement. The shackle is a finely crafted Mughal specimen in the trifoliate form. The finial of the *kursī* is also trifoliate. The *kursī* is finely pierced. The profiles consist of an ogee at the base, followed by scallops and lobes. Decorative engraving on the surface of the *kursī* on both sides.

The limb is divided in 1° and 5° and numbered from 5 to 90, separately in each quadrant.

Figure A028.2 – Rete of the Astrolabe (photo by S. R. Sarma)

Rete

The Capricorn ring and the much wider ecliptic ring are held together by the equinoctial bar which has counter changes at its two intersections with the ecliptic ring. The latter is divided in the 12 signs of the zodiac and labelled with their names; each sign is subdivided into units of 6° and numbered accordingly. These units are halved on the sloping edge of the ecliptic ring.

This rete is the most unusual among Muqīms astrolabes in that it carries no floral tracery to connect the various star pointers. In the lower half, outside the ecliptic ring, the star pointers are joined to the mainframe by an X-shaped bridge straddling the meridian and by two nearly straight bars on either side. Inside the ecliptic ring, there is an interesting formation containing a quatrefoil. Unlike the retes in other Lahore astrolabes, there are large open spaces in this rete. The star pointers are shaped mostly like tiger's claws. There are several unnamed pointers placed for the sake of symmetry.

Table A028-1 Stars on the Rete

	Star Name	Identification
01	*Dhanab al-qayṭus J[anūbī]*	β Ceti
02	*Baṭn al-Ḥūt*	β Andromedae
03	*Rijl al-Musalsala*	γ Andromedae
04	*Fam al-Qayṭus*	γ Ceti
05	*Ṣadr al-Qayṭus*	π Ceti
06	*Ghūl*	β Persei
07	*Tālī Masāfat al-Nahr*	γ Eridani
08	*ᶜAyn [al-Thawr]*	α Tauri
09	*ᶜAyyūq*	α Aurigae
10	*Rijl Yusrā*	β Orionis
11	*Yad Yusrā*	γ Orionis
12	*Yad Yumnā*	α Orionis
13	*Rijl Yumnā*	κ Orionis

	Star Name	Identification
14	*[Shi^{c}rā] Yamānī*	α Canis Majoris
15	*[Shi^{c}rā] Shāmiya*	α Canis Minoris
16	*Minkhar Shujā^{c}*	σ Hydrae
17	*Qā^{c}idat al-Bāṭiya*	α Crateris
18	*Janāḥ al-Ghurāb*	γ Corvi
19	*Simāk al-A^{c}zal*	α Virginis
20	*^{c}Anāq*	ξ Ursae Majoris
21	*Simāk Rāmiḥ*	α Bootis
22	*Nayyir Fakka*	α Coronae Borealis
23	*^{c}Unuq al-Ḥayya*	α Serpentis
24	?	
25	*Rās al-Jāthī*	α Herculis
26	*Rās al-Ḥawwā'*	α Ophiuchi
27	*Yad [al-Ḥawwā']*	δ Ophiuchi
28	*Al-Wāqi^{c}*	α Lyrae
29	*Minqār [al-Dajāja]*	β Cygni
30	*Nasr Ṭā'ir*	α Aquilae
31	*Dhanab Dulfīn*	ε Delphini
32	*Dhanab Dajāja*	α Cygni
33	*Dhanab al-Jadī*	δ Capricorni
34	*Fam Faras*	ε Pegasi
35	*Sāq Sākib al-Mā'*	δ Aquarii
36	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
37	*Mankib Faras*	β Pegasi

	Star Name	Identification
38	*Surrat Faras*	δ Pegasi
39	*Khaḍīb*	β Cassiopeiae

PLATES

At present there are four plates; there is space for one more plate which may have been lost. Altitude circles are drawn for every 3° and every fifth circle is highlighted by dots. Their labelling is not consistent. Azimuths are drawn below the horizon for every 10° and labelled. The horizontal and vertical diameters, the oblique horizon and prime meridian below the horizon are all dotted. The east and west points on the horizon are labelled *al-mashriq* and *al-maghrib* respectively.

Lines for seasonal hours are drawn. Dotted lines are for equal hours are drawn on some plates from the western horizon and from the eastern and western horizons on some other plates.

Table A028-2 Plates

	φ	Longest day
1a	22°	13;22 hours
1b	25°	13;35 hours
2a	27°	13;46 hours
2b	32°	14;8 hours
3a	36°	14;32 hours
3b	40°	14;54 hours
4a	Tablet of ecliptic coordinates	
4b	Tablet of horizons	

GEOGRAPHICAL GAZETTEER

The gazetteer is drawn in three concentric circles, listing 69 localities, roughly according to their longitudes in ascending order. In the outer circle, the letters are upside-down. Here the sequence of the entries is: latitude, locality, longitude. In the second and third circles, they are upright; here the sequence of the entries is: longitude, locality, latitude. In the table below, the entries are registered with a uniform sequence of locality, longitude and latitude.

Figure A028.3 – Geographical gazetteer (photo by S. R. Sarma)

Table A028-3 Geograhical Gezetteer

	Place Name	L	φ
	Outer Circle		
01	Qayrawān	41;0	30;40
02	Miṣr	63;20	30;20
03	ᶜAdan	76;0	11;0

	Place Name	L	φ
04	Madīnat Ṭayyaba	75;20	25;0
05	Makka Musharraf	77;10	21;40
06	Ṭā'īf	77;30	21;20
07	Bayt al-Maqdis	66;30	31;50[288]
08	Dimashq	70;0	33;15
09	Ḥalab	72;10	35;50
10	Mawṣil	77;0	30;30[289]
11	Nakhjawān	81;15	38;40
12	Tabrīz	82;0	38;0
13	Bardaᶜa	83;0	40;30
14	Kūfa	79;30	31;30
15	Madā'īn	72;0	33;10
16	Baghdād	80;0	33;25
17	Baṣra	84;0	30;0
18	Fīrūzābād	87;30	28;10
19	Shīrāz	88;0	29;36
20	Yazd	89;0	32;40
21	Hamadān	83;0	35;10
22	Sāwa	85;0	35;0
23	Qazwīn	85;0	36;0
24	Iṣfahān	86;40	34;25

288 Here Muqīm engraved the latitude in the column for the longitudes and the longitude in the column of the latitudes.

289 Here the engraver first engraved the longitude value; then erased it and engraved 30;30.

	Place Name	L	φ
25	Kāshān	86;0	34;0
26	Qum	85;40	34;45
27	Rayy	86;20	35;0
28	Astarābād	89;35	36;50
29	Bisṭām	89;30	36;10
30	Sabzawār	91;30	36;0
31	Nīshābūr	92;30	36;21
	Middle Circle		
32	Mashhad	92;30	37;0
33	Tūn	92;30	34;30
34	Qā’īn	93;20	33;40
35	Harāt	94;20	34;30
36	Marw	97;0	37;40
37	Balkh	101;0	36;41
38	Badakhshān	84;24	37;10
39	Bukhārā	97;30	39;50
40	Samarqand	99;16	39;37
41	Khujand	100;35	41;50
42	Kāshghar	106;30	44;0
43	Khutan	107;0	42;0
44	Hurmūz	92;0	25;0
45	Kirmān	91;30	30;5
46	Ghazna	104;20	33;35
47	Kābul	104;40	34;30

	Place Name	L	φ
48	Tubbat	110;0	40;0
49	Kashmīr	108;0	35;0
50	Qandahār	107;40	33;0
51	Tatta	102;30	25;10!
52	Bakar	105;0	27;40 (Mansura al-Sind)
53	Mūltān	107;35	29;40
54	Lāhūr	109;20	31;50
	Inner Circle		
55	Dihlī	113;35	28;39
56	Akbarābād	115;0	26;43
57	Qannawj	115;50	26;35
58	Banāras	117;20	26;55
59	Jawnpūr	119;6	26;30
60	Ajmīr	112;0	26;0
61	Jaddah	76;0	?
62	Ujjayn	110;50	23;30
63	Burhānpūr	113;0	20;30
64	Dawlatābād	111;0	20;30
65	Bijāpūr	105;30	16;20
66	Kolkanda	114;19	28;3 !
67	Aḥmadābād	108;40	23;15
68	Sarandīb	130;0	10;0
69	Kanbāyat	109;20	26;10

Figure A028.4 – Back of the astrolabe (photo by S. R. Sarma)

BACK

On the back, the rim of the two upper quadrants carries the two altitude scales, divided in 1° and 5° and labelled as 5—90; 90—5.

The upper left quadrant carries a sine-cosine grid with 30 horizontal and 30 vertical parallels, where each third is highlighted with dots. In the upper right quadrant, six declination arcs are drawn so that each zone between them represents two zodiac

signs, which are marked with their serial numbers (0 = Aries) along the two radii. Two graphs of the solar meridian altitudes for the latitudes 27° and 32° are superimposed on these quarter circles, with the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27; khaṭṭ niṣf al-nahār bi-ᶜarḍ 32* respectively.

The six declination arcs do not occupy the entire quadrant; some space is left near the apex where a table of six columns and six rows is engraved. It contains the table of triplicities; the table is the same as in A026, but without the four labels nārī (fiery), tarābī (earthy), hawā'ī (airy) and mā'ī (watery) which classify the signs according to the four elements.

A later hand tried to draw a crude shadow square on this quadrant with an angle greater than 90°!

In the lower half there are shadow squares, on the left for the base of 12 and on the right for 7. The vertical and horizontal scales are divided and numbered accordingly and are endowed with the following labels:
Vertical scale on the left: *ẓill sullam aṣābiᶜ maᶜkūs* (scale of reverse shadows in digits)
Horizontal scale on the left: *ẓill sullam aṣābiᶜ mustawī* (scale of direct shadows in digits)
Horizontal scale on the right: *ẓill sullam aqdām mustawī* (scale of direct shadows in feet)
Vertical scale on the right: *ẓill sullam aqdām maᶜkūs* (scale of reverse shadows in feet).

On the rim of the lower half are engraved the two corresponding cotangent tables. The scale on the left is divided in digits and bears a label to this effect at the end: (*al-aṣābiᶜ*). The unequal divisions are numbered 5, 10, 12, 15, 20, 25, 30, 36, 42, 48, 54 and 60. Each of these divisions are subdivided into 5 units each in the semi-circular band inside.

The scale on the right is divided in feet and bears a label to this effect at the end: *al-aqdām*. The unequal divisions are numbered 5, 7, 10, 15, 20, 25, 30, 36, 42, 48, 54 and 60. Each of these divisions are subdivided into 5 units each in the semi-circular band inside.

Below the scales of cotangents, there are three semi-circular rows containing the table of limits (*ḥudūd*).

Again, inside the shadow squares, there are four semi-circular rows. The first two are filled with the names of the 28 lunar mansions and the corresponding zodiac signs,

the latter in serial numbers from 0 to 11. The next two rows contain a table of decans (*wujūh*) and their regents.

ALIDADE

The alidade is plain without any scales; it appears to be a replacement.

INSCRIPTION

In the limited space between the horizontal diameter and the semi-circular rows is the maker's signature, engraved in two lines:

*ṣan*ᶜ*at aḍ*ᶜ*af al-*ᶜ*ibād muḥammad muqīm ibn* ᶜ*īsā*

ibn allāhdād asṭurlābī humāyūnī lāhūrī

'The work of the weakest of the servant [of God], Muḥammad Muqīm, son of ᶜĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.'

The year of manufacture is engraved below the shadow squares: *fī sanah 1051 hijrī* (in the year 1051 Hijrī [= AD 1641-42]).

PROVENANCE

Ex. Collection Nicolas Landau, Paris; ex. Collction J. A. Billmeir, Elstead, Surrey, UK.

BIBLIOGRAPHY

Maddison 1957, No. 160, p. 22.

A029⊙ ASTROLABE BY MUḤAMMAD MUQĪM; AH 1051 (AD 1641-42)[290]

Diameter 134 mm

Greenwich, National Maritime Museum (# AST0579)

CCA 1054; Répertoire 14

Figure A029.1 – Front of the astrolabe (photo by S. R. Sarma)

COMPONENTS

Body with *kursī* (d. 134), shackle and ring, rete for 36 stars, 5 plates, alidade, pin and horse.

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[290] This entry is based on personal examination in 1993 and on Charette 2005b.

FRONT

The shackle and ring are replacements. The *kursī* is intricately pierced somewhat similar in style to that in the previous astrolabe, with three heart-shaped frames. The finial is trifoliate. The limb is divided in 1° and 5° and numbered in 5s from 5 to 360.

RETE

The Capricorn ring and ecliptic ring are joined by the equinoctial bar which has counter changes at its two intersections with the ecliptic ring. The solstitial bar is partly represented. The star pointers are not joined by a tracery vines and tendrils with leaves and flowers, but by unconnected segments. There are 36 stars pointers; many of them are curved like tiger's claws.

Table A029-1 Stars on the Rete

	Star Name	Identification
01	*Dhanab Qayṭus J[anūbī]*	β Ceti
02	*Baṭn Qayṭus*	ζ Ceti
03	*Rijl Musalsala*	γ Andromedae
04	*Ṣadr Qayṭus*	π Ceti
05	*Fam Qayṭus*	γ Cet
06	*Ghūl*	β Persei
07	*Tālī masāfat al-Nahr*	γ Eridani
08	*Dabarān*	α Tauri
09	*ᶜAyyūq*	α Aurigae
10	*Yad Yumnā*	α Orionis
11	*Rijl al-Jawjā' Yumnā*	κ Orionis
12	*Shiᶜrā Yamānī*	α Canis Majoris
13	*Shiᶜrā Shāmī*	α Canis Minoris
14	*Minkhar al-Shujāᶜ*	σ Hydrae
15	*Fard al-Shujāᶜ*	α Hydrae

	Star Name	Identification
16	*Qācidat al-Bāṭiya*	α Crateris
17	*Janāḥ al-Ghurāb*	γ Corvi
18	*Simāk A^c^zal*	α Virginis
19	*Al-^c^Anāq*	ζ Ursae Majoris
20	*Simāk Rāmiḥ*	α Bootis
21	*Nayyir Fakka*	α Coronae Borealis
22	*^c^Unuq al-Ḥayya*	α Serpentis
23	*Rukbat [al-Ḥawwā’] Yusrā*	ρ Ophiuchi
24	*Rās al-Jathī*	α Herculis
25	*Yad muqaddam*	δ Opiuchi
26	*Wāqi^c^*	α Lyrae
27	*Minqār Dajāja*	β Cygni
28	*Nasr Ṭā’ir*	α Aquilae
29	*Dhanab al-Dulfīn*	ε Delphini
30	*Dhanab al-Dajāja*	α Cygni
31	*Dhanab al-Jadī*	δ Capricorni
32	*Fam al-Faras*	ε Pegasi
33	*Sāq Sākib a[l-Mā’]*	δ Aquarii
34	*Dhanab Qayṭus Sh[amālī]*	ι Ceti
35	*Mankib Faras*	β Pegasi
36	*Khaḍīb*	β Cassiopeiae

PLATES

There are five plates; altitude circles are drawn for every 6°; azmith arcs are traced for every 10° sometimes below the horizon, sometimes above, and some other times both above and below.

Table A029-2 Plates

	φ	Longest Day
1a	22°	13 hours
1b	25°	13 hours!
2a	27°	13;43 hours
2b	32°	14;8 hours
3a	36°	14 hours
3b	40°	14 hours
4a	0° + 90°	
4b	18° + 72°	
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

GEOGRAPHICAL GAZETTEER

On the inner side of the mater is engraved a geographical gazetteer in three concentric circles containing the names, longitudes and latitudes of 69 localities. The localities are arranged in ascending order of their longitudes. The writing proceeds clockwise in the outer circle and anticlockwise in the two inner circles.

Table A029-3 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle (clockwise)		
01	Qayrawān	41;0	31;40

	Place Name	L	φ
02	Miṣr	63;20	30;20
03	ᶜAdan	76;0	11;0
04	Madīnat Ṭayyaba	75;20	25;0
05	Makka Musharraf	77;0	21;40
06	Tā’if	77;30	21;20
07	Bayt al-Maqdis	66;30	31;50
08	Dimashq	70;0	33;15
09	Ḥalab	72;10	35;50
10	Mawṣil	77;0	34;30
11	Nakhjawān	81;15	38;40
12	Marāgha	82;0	37;20
13	Tabrīz	82;0	38;0
14	Bardaᶜa	83;0	40;30
15	Kufa	79;30	31;30
16	Baghdād	80;0	33;25
17	Baṣra	84;0	30;0
18	Fīrūzābād	87;30	28;10
19	Shīrāz	88;0	29;36
20	Yazd	89;0	32;0
21	Qazwīn	85;0	36;0
22	Iṣfahān	86;40	32;25
23	Kāshān	86;0	34;0
24	Qum	85;40	34;45
25	Rayy	86;20	35;0

	Place Name	L	φ
26	Astarābād	89;35	36;50
27	Biṣṭām	89;30	36;10
28	Mashhad	92;30	36;0
29	Tūn	92;30	34;30
30	Harat	94;20	34;30
31	Marw	97;0	37;40
	Middle Circle (anticlockwise)		
32	Balkh	81;0	36;41
33	Badakhshān	84;24	37;10
34	Bukhārā	97;30	39;50
35	Samarqand	99;16	39;37
36	Khujand	100;35	41;55
37	Kāshghar	106;30	44;0
38	Khutan	107;0	42;0
39	Hurmūz	92;0	25;0
40	Kirmān	91;30!	30;5
41	Ghazna	104;20	33;35
42	Kābul	104;40	34;30
43	Tubbat	110;0	40;0
44	Kashmīr	108;0	35;0
45	Tana	102;30	25;10
46	Bakar	105;0	27;40 (Mansura al-Sind)
47	Qandahār	107;40	33;0
48	Multān	107;35	29;40

	Place Name	L	φ
49	Lāhūr	109;20	31;50
50	Sālkot	109;0	33;0
51	Pānīpata	113;20	28;52
52	Tānīsar	112;33	30;10
53	Haḍrat Dihlī[291]	113;35	28;39
54	Akbarābād	115;0	26;43
	Inner circle (anticlockwise from the top)		
55	Qannawhāj !	115;50	26;35
56	Banāras	117;20	25;55
57	Kawālīyar	115;0	26;29
58	Jawnpūr	119;0	26;36
59	Jidda	77;0	21;0
60	Ujjayn	110;50	23;30
61	Ajmīr	111;5	26;0
62	Saronj (?)	72;40	34;50
63	Aḥmadābād	108;40	23;15
64	Burhanpūr	103;0	20;30
65	Bījāpūr	105;30	16;20
66	Dawlatābād	110;0	20;30
67	Kalkanda	114;19	28;4 !
68	Sarandib	130;0	10;0
69	Kanbayāt	109;4	22;20

291 Spelt wrongly as 'Hadrab Dihlī'

Figure A029.2 – Back of the astrolabe (photo by S. R. Sarma)

BACK

The back of this astrolabe is designed almost exactly like the back of the astrolabe A028 which too was made in the same year. The rim on the upper half bears the two altitude scales, divided in 1° and 5°, and numbered in 5s as 5—90; 90—5.

In the upper left is the trigonometric quadrant which carries 30 vertical and 30 horizontal parallels where each fifth is dotted.

The solar quadrant in the upper right is divided by declination arcs into 6 zones, one for each pair of zodiac signs; the signs are labelled along the two radii; from *al-Saraṭān* to *al-Qaws* along the vertical radius and from *al-Jawjā'* to *al-Dalw* along the horizontal radius. Moreover, two sigmoid graphs of the solar altitude at midday are traced on this quadrant with the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ 32* respectively.

As astrolabe A029, here also the table of triplicities is engraved at the apex of the quadrant, without the labels *nārī, tarābī, hawā'ī* and *mā'ī.*

Shadow squares are drawn in the middle of the lower half. On the left these are drawn for a base of 12 digits; the horizontal and vertical scales are divided into 12 units each and numbered accordingly. They are labelled respectively as
ẓill sullam aṣābiᶜ mustawī (scale of the direct shadows in digits) and
ẓill sullam aṣābiᶜ maᶜkūs (scale of the reverse shadows in digits)

On the right the base is 7 feet; the horizontal and vertical scales are divided into 12 units each and numbered accordingly. They are labelled respectively as
ẓill sullam aqdām mustawī (scale of the direct shadows in feet) and
ẓill sullam aqdām ma ᶜkūs (scale of the reverse shadows in feet).

The rim of the lower half carries cotangent scales. Inside these scales, there are three semi-circular rows containing the table of limits (*ḥudūd*). Again, inside the shadow squares there are four semi-circular rows. The first two are filled with the names of the 28 lunar mansions and the corresponding zodiac signs, the latter in serial numbers from 0 to 11. The next two rows contain a table of decans (*wujūh*) and their regents.

ALIDADE

The alidade has ornate ends and an ornate centre-piece. The right half carries a sexagesimal scale which is divided every 6 and 2 units, and sundial markings for hours 1/12, 2/11, 3/10, and 4/9. On the left half is engraved the scale of solar longitude.

The wedge is a modern replacement; it bears a label 'S.P.1970'.

INSCRIPTION

The maker's signature is engraved upside down below the table of limits:

ṣanaᶜat bi-yad aḍaᶜaf al-ᶜibād muḥammad muqīm ibn ᶜīsā
ibn allāhdād asṭurlābī humāyūnī lāhūrī

> ‘Made by the hand of the least of the servants [of God], Muḥammad Muqīm, the son of ᶜĪsā, the son of Allāhadād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.’

The year of manufacture is written in the space between the horizontal diameter and the semi-circular tables: *fī sanah 1051 hijrī* (in the year 1051 Hijrī [= AD 1641-42]).

PROVENANCE

Presented by Captain R. K. Dickson on 29 August 1946.

BIBLIOGRAPHY

Charette 2005b.

A030⊙ ASTROLABE BY MUḤAMMAD MUQĪM, AH 1053 (AD 1643-44)

Diameter 167 mm

Oxford, Museum of the History of Science (#43704)

CCA 72; Répertoire 15

Figure A030.1 – Front of the astrolabe (photo by S. R. Sarma)

Components

Body with *kursī* (d. 167, h.225, t. 9), shackle and ring, rete (d. 155) for 38 stars, 5 plates (d. 156), alidade, pin and horse.

Front

The ring has a diamond cross-section; the ends are not soldered together. The shackle also has a diamond cross-section; its form is more oval than trifoliate; the bases are trifoliate. The profiles of the *kursī* are made up of ogees at the base and top with a lobe in the middle. The finial is trifoliate. The *kursī* is finely pierced and the upper surface on the front and back is decorated with hatching.

The limb is divided in 1° and 5° and labelled in 5s from 5 to 360.

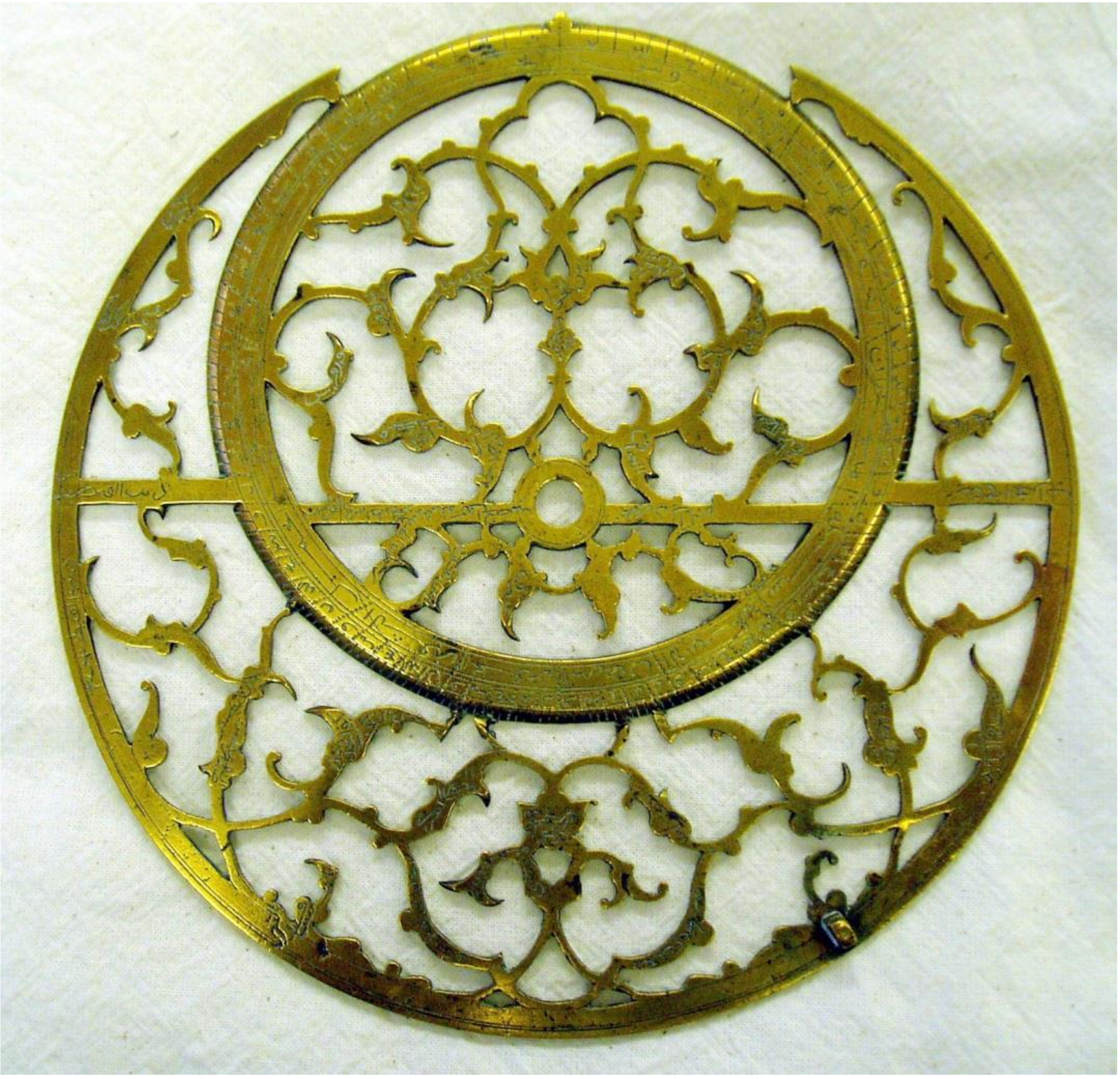

Figure A030.2 – Rete of the astrolabe (photo by S. R. Sarma)

Rete

The Capricorn ring and the ecliptic ring are held together by the equinoctial bar which has counter changes at its two intersections with the ecliptic ring. The latter is divided into 12 signs and labelled with their names; each sign is further subdivided into units of 6° and again into units of 2°. There are 38 star pointers, 17 outside the ecliptic and 21 inside. These are slightly curved with very sharp tips. These star pointers are joined to the main frame by a tracery of intersecting circles and triangles; this design matches nicely with that the *kursī*. There is a handle on the peripheral ring to the right of the north point.

Table A030-1 Stars on the Rete

	Star Name	Identification
01	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
02	*Rijl Musalsala*	γ Andromedae
03	*Fam al-Qayṭus*	γ Ceti
04	*Ṣadr al-Qayṭus*	π Ceti
05	*Kaff al-Jadhmā'*	α Ceti
06	*Rās al-Ghūl*	β Persei
07	*Tālī Masāfat al-Nahr*	γ Eridani
08	*ᶜAyyūq*	α Aurigae
09	*Rijl al-Jawjā' Yusrā*	β Orionis
10	*Yad al-Jawjā' Yusrā*	γ Orionis
11	*Yad al-Jawjā' Yumnā*	α Orionis
12	*Rijl al-Jawjā' Yumnā*	κ Orionis
13	*Shiᶜrā Yamānī*	α Canis Majoris
14	*Shiᶜrā Shāmī*	α Canis Minoris
15	*Fard al-Shujāᶜ*	α Hydrae
16	*Ẓahr Dubb Akbar*	α Ursae Majoris

	Star Name	Identification
17	*Qā^cidat al-Bāṭiya*	α Crateris
18	*Ẓahr al-Asad*	δ Leonis
19	*Janāḥ al-Ghurāb*	γ Corvi
21	*Simāk A^czal*	α Virginis
20	*Al-^cAnāq*	ζ Ursae Majoris
22	*Simāk Rāmiḥ*	α Bootis
23	*Nayyir Fakka*	α Coronae Borealis
24	*^cUnuq al-Ḥawwā'*	α Serpentis
25	*Rās al-Jāthī*	α Herculis
26	*Rās al-Ḥawwā'*	α Ophiuchi
27	*Nasr Wāqi^c*	α Virginis
28	*Nasr Ṭā'ir*	α Aquilae
29	*Minqār Dajāja*	β Cygni
30	*Dhanab Dulfīn*	ε Delphini
31	*Dhanab al-Dajāja*	α Cygni
32	*Fam Faras*	ε Pegasi
33	*Dhanab al-Jadī*	δ Capricorni
34	*Sāq Sākib al-Mā' J[anūbyya]*	α Aquarii
35	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
36	*Mankib Faras*	β Pegasi
37	*Surrat al-Faras*	δ Pegasi
38	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are five plates with the following specifications:

Table A030-2 Plates

	φ	Longest Day
1a	22°	13;21 hours
1b	25°	13;25 hours
2a	27°	13;46 hours
2b	32°	14;8 hours
3a	36°	14;32 hours
3b	40°	14;52 hours
4a	23°	13;24 hours
4b	0° + 72° + 90°	
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons with notches at the four cardinal points	

On plates 1-4, altitude circles are drawn for every 2° with each fifth circle dotted. Azimuth arcs are traced for every 6° below the horizon; plain lines for seasonal hours and dotted lines from the western horizon for equal hours.

The tablet of ecliptic coordinates and the tablet of horizons have the usual projections, but no labels. Interestingly the plate has four notches at the pour points of the compass, so that all the four sets of horizons can be made use of. In theory all horizon plates should have four such notches in order to be functional, but very rarely they do.

Of special interest is 4b which has a composite projection for the three latitudes 0°, 72° and 90°.[292] The upper half carries the stereographic projections for the latitude 0°. Here the horizontal diameter is the horizon. Below the line of horizon in the west

[292] See also A047; Sottas 1930, pp. 171-173.

and in the east are the labels *lā ᶜarḍ lahu* (there is no latitude). The altitude circles are drawn for each 3° and every fifth highlighted with dots. These are numbered on both sides of the meridian. Azimuth arcs are traced for every 10° above the horizon. They are drawn completely in the upper left quadrant and numbered along the horizon. In the upper right quadrant, they are drawn partially and make way for the projections of latitude 72°.

The stereographic projections for latitude 90° are drawn in the lower left quadrant. Here the equator constitutes the horizon; it is drawn as a full dotted circle. Altitude circles are drawn for every 3° both above and below the equator-horizon. Every fifth circle is highlighted with dots. The altitude circles above the equator-horizon are numbered from 3 to 90. The circle at 24° is drawn somewhat bold; it is the Tropic of Cancer. The altitude circles below the equator-horizon are numbered from 3 to 18. Below the line of equator-horizon is the label *ᶜarḍ tisᶜūn* (latitude 90 [degrees]).

The stereographic projections for latitude 72° (arctic circle) are traced in the lower right quadrant and partially also in the upper right quadrant. Here the horizon is represented by a dotted circle drawn eccentrically. Here also there are altitude circles for every 3°, numbered along the meridian up to a point slightly below the centre. From this point radiate the azimuth arcs at intervals of 10°; these are numbered above the horizon. Below the horizon is engraved the label *al-ᶜarḍ 72*.

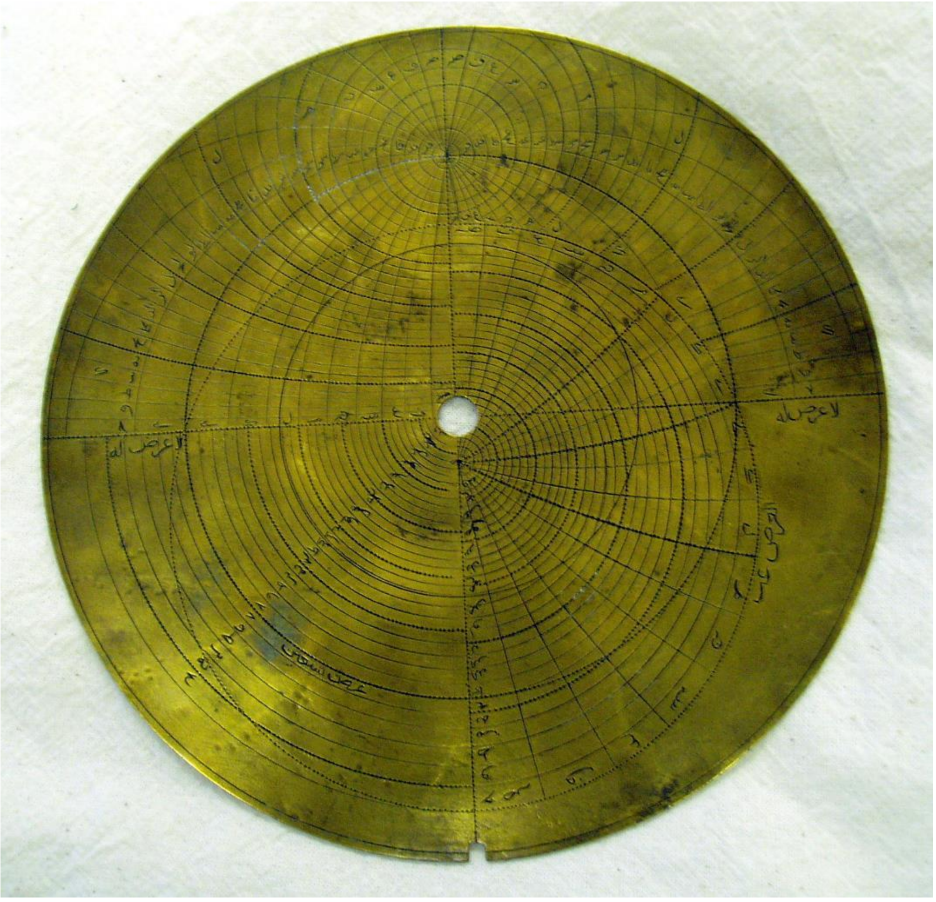

Figure A030.3 – Triple projection for latitudes 0°, 72° and 90°(photo by S. R. Sarma)

GEOGRAPHICAL GAZETTEER

The gazetteer is engraved in four circles for 116 localities arranged according to climates. The circles are separated by blank rows bounded by double lines on either side. The names of climates are engraved in the blank rows, not in elongated strokes as in other astrolabes, but in a compact form. The actual entries are in two lines, each separated from the next by two vertical strokes ‖. Again in each entry, the name of the locality is written in the first line; below that in the second line, the longitude and the latitude are written in the same row, separated by two vertical strokes ‖. Strangely, there are no arguments in the first cell of each row.

Figure A030.4 – Geographical Gazetteer (photo by S. R. Sarma)

Table A030-3 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
[-I] *az khaṭṭ istiwā’ tā iqlīm awwal* (from the line of equator up to the first climate)			
01	Sāḥil Baḥr Awqiyānūs[293]	11;0	0;0
02	Jazīra Qanbala	21;00	3;0

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293 Ocean coast of the Oceanus. Oceanus (Greek *Okeanos*) is said to be the divine personification of the sea that encircles world.

	Place Name	L	φ
03	Hadiya	66;0	7;0
04	ᶜAdan	76;0	11;0
05	Sarāndīb	130;0	10;0
06	Jamkūt	177;0	5;0
07	Kankandaz[294]	106;0	0;0
[I] *al-iqlīm al-awwal* (the first climate)			
08	Dunqula	63;0	60;0!
09	Jabil	75;0	13;30
10	Janad	75;6	14;30
11	Ṣanᶜān	77;0	14;30
12	Zītūn	114;0	17;0
13	Bījāpūr	105;30	17;20
[II] *al-iqlīm al-thānī* (the second climate)			
14	Madīnat Tayyaba	75;20	25;0
15	Makka Muᶜaẓẓama	77;10	21;40
16	Hurmūz	92;0	25;0
17	Qannwj	115;50	26;15
18	Banāras	117;20	26;15
19	Kawālīyar	114;0	26;29
20	Akbarābād	115;0	26;43
21	Kara wa Mānikpūr	118;10	26;19
22	Lakhnawti	114;13	26;30

294 The name is so engraved; cf. Kennedy 1987a, s.v. Kang and Kangdezh, p. 171.

	Place Name	L	φ
23	Kūpāmāvū	116;10	26;43
24	Badāūn	119;59	27;32
25	Jawnbūr	119;6	26;36
26	Awadh	118;6	26;22
27	Ajmīr	111;5	26;0
28	Mandū	111;25	27;15!
29	Sārankbūr	112;30	23;20
30	Narwar	114;0	25;20
31	Patan	104;30	22;0
32	Bahrūj	109;45	21;20
33	Juyūl[295]	106;40	19;0
34	Tānah	114;5	19;20 Thane
35	Aḥmadābād	108;40	23;15
36	Burhānpūr	113;0	20;30
37	Dawlatābād	104;0	20;30
38	Kanbāyat	109;20	22;30
[III] *al-iqlīm al-thālith* (the third climate)			
39	Asfī	12;15	30;15
40	Qayrawān	41;15	31;15
41	Mahdiyya	92;15 !	32;30
42	Iskandariyya	61;54	30;18

[295] Kennedy 1987a, p. 167, says that this place is on the coast of India; the only authority he cites is al-Bīrūnī's *Al-Qānūn al-Mas^cūdī.* It is not mentioned in Abū'l-Faḍl's *Ā'īn-i Akbarī*, indexed in Kennedy 1987a, pp. 569-580. The place ought to be on the west coast of India, north of Mumbai, but I cannot identify it.

	Place Name	L	φ
43	Miṣr	63;15	30;20
44	Bayt al-Maqdis	66;30	31;50
45	ᶜAmmān	67;20	31;0
46	Dimashq	70;0	33;20
47	Ḥala	79;15	32;15
48	Kūfa	79;30	31;30
	Second Circle		
[III] *tatimma iqlīm thālith* (continuation of the third climate)			
49	Baghdād	80;15	33;20
50	Madā'īn	80;20	33;0
51	Bāb al-ᶜIrāq	80;15	33;0
52	Ḥalwān	84;55	34;0
53	Baṣra	84;0	30;0
54	Iṣfahān	87;40	32;25
55	Fīrūzābād	87;30	28;10
56	Shīrāz	88;0	29;30
57	Multān	107;25	29;40
58	Bakr	105;0	27;40
59	Kirmān	94;30	30;5
60	Parashwar	85;55	31;0
61	Qandahār	107;40	33;0
62	Sālkūt	109;0	33;0
63	Lāhūr	109;20	31;50
64	Dihlī	113;35	28;39

	Place Name	L	φ
65	Tānīsar	114;33	30;10
66	Samīr ?	85;40	32;15
67	Kolkanda	114;19	28;3
[IV] *al-iqlīm al-rābi*[c] (the fourth climate)			
68	[c]Ānah	75;30	38;45
69	Tūn	92;30	34;30
70	Harat	94;20	34;30
71	Qum	105;40!	34;45
72	Rayy	86;20	35;0
73	Sāwa	85;0	35;0
74	Kashmīr	108;0	35;0
75	Hamadān	83;0	35;10
76	Ḥalab	72;10	35;50
77	Mashhad	92;30	36;0
78	Sabzawār	91;30	36;5
79	Busṭām	89;30	36;10
80	Balkh	101;0	36;11
	Third Circle		
[IV] *tatimmah iqlīm rābi* [c] (continuation of the fourth climate)			
81	Nīshābūr	92;30	36;21
82	Ṭāliqān	85;45	36;10
83	Astarābād	89;35	36;50
84	Qazwīn	85;30	36;35
85	Badakhshān	104;24	37;10

	Place Name	L	φ
86	Marāgha	82;0	37;20
87	Marw	97;0	37;40
88	Tabrīz	82;0	38;0
89	Ardabīl	80;30	38;0
[V] *al-iqlīm al-khāmis* (the fifth climate)			
90	Nakhjawān	81;15	38;40
91	Samarqand	99;16	39;37
92	Bīkand	97;30	39;45
93	Bukhārā	97;30	39;50
94	Tubbat	110;0	40;0
95	Bardaᶜa	83;0	40;30
96	S[h]amākhī	84;30	40;50
97	Khujand	105;35	41;55
98	Khutan	107;0	42;0
99	Kāshān	101;35	42;0
100	Bāb al-Abwāb	85;0	43;0
101	Aylāq	99;10	43;20
[VI] *al-iqlīm al-sādis* (the sixth climate)			
102	Ḥalqiya	20;0 !	47;0
103	Yanbalūna	34;55	45;15
104	Bandqīya	42;0	44;0
	Fourth Circle		
[VI] *tatimma al-iqlīm sādis* (continuation of the sixth climate)			
105	Haraqla	67;20	46;30

	Place Name	**L**	**φ**
106	Fārāb	88;30	45;0
107	Kāshghar	106;30	44;0
108	Bīsh Bāligh	111;0	45;50
109	Khān Bāligh	134;0	46;0
[VII] *al-iqlīm al-sābi*ᶜ (the seventh climate)			
110	Aqjākirmān	65;0	50;0
111	Qirqir	65;30	50;0
112	Ṭirnū	67;30	50;15
113	Araq	85;0	48;0
114	Ṣarāy	86;0	48;0
115	Akla	88;0	49;0
[VII+] *khārij iqlīm haftum* (beyond the seventh climate)			
116	Mārīkirmān	65;45	50;40
117	Ṣūdāq	66;0	51;0
118	Jazāīr Rūd Hard	---	62;0
119	Jazāīr Qūlī	---	65;0
120	Nahāya Baḥr Awqiyānūs[296]	---	71;0

BACK

The rim on the back is wider than the limb in the front. The rim of the two upper quadrants carries the altitude scales, which are divided in 1° and 5° and labelled 5—90; 90—5.

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[296] End (*nahāya*) of the encircling ocean called Oceanus cf. Kennedy 1987a, p. 248.

The upper left quadrant is occupied by a sine-cosine graph with 60 horizontal and 60 vertical parallels, each fifth of which is highlighted with dots. In the upper right quadrant are traced declination circles for each 5° of solar longitude. These are labelled by the names of the zodiac circles along the two radii. The names of the signs from summer solstice to winter solstice, viz. *al-Saraṭān* to *al-Qaws,* are written along the vertical radius from the centre up to the periphery and the names of the signs from winter solstice to summer solstice, viz. *al-Jadī* to *al-Jawzā',* along the horizontal radius from the periphery to up to the centre. Above or next to these names the subdivisions of signs are numbered from 6 to 30, separately for each sign. In addition, two sigmoid graphs of the midday altitude of the sun throught the year are plotted for the latitudes 27° and 32° with the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ 32* respectively.

In the lower half are shadow squares, on the left for a base of 12 and 60 and on the right for 7. The vertical and horizontal scales are drawn in three bands each. The inner band is divided in 12 units and numbered from the centre from 1 to 12 up to the end of horizontal scale and from 12 to 1 in the vertical scale. The middle band is divided in sexagesimal units. These are numbered in 5s in the outer band; from the centre onwards as 5, 10, 15, … 60 in the horizontal scale and again as 60, 55, 50, … 1 in the vertical scale. The horizontal scale of 12 is labelled as *ẓill sullam aṣābiᶜ mustawī* and the vertical scale *ẓill sullam aṣābiᶜ maᶜkūs.* The scale of 60 in the outer band has a new name; the horizontal scale is entitled *ẓill sittaynī mustawī* (sexagesimal direct shadow) and the vertical scale *ẓill sittaynī maᶜkūs* (sexagesimal reverse shadow). This sexagesimal scale occurs here for the first time on Lahore astrolabes.

The scale on the right has only a single band divided in 7 units and numbered accordingly. The labels are *ẓill sullam aqdām mustawī* for the horizontal scale and *ẓill sullam aqdām maᶜkūs* for the vertical scale. In an outer band adjoining the horizontal and vertical scales is engraved the maker's signature which will be discussed below.

Inside the shadow scales, there are 6 semi-circular rows, separated by double lines. In the first row (as counted from the outside) are engraved the names of the 28 lunar mansions and in the second row the names of the 12 corresponding zodiac signs. The next two rows contain the table of limits (*al-ḥudūd*) and the last two lines the decans (*al-wujūh*) and their regents as in A016 and A026.

These 6 semi-circular rows enclose the rectangular table of triplicities written upside down with the heading *arbāb muthallathāth laylī wa nahārī* (the regents of the triplicities at night and in the day). As in the two previous case (A026 and A027), the table avoids the four-fold classification according to the elements.

Finally, below the shadow squares, there is one more table entitled *faḍl al-dawr* (excess of revolution) as in A016 and A026.

ALIDADE ETC

The alidade and the wedge are plain and not original. The pin is original, its head is shaped like a lotus with 16 petals.

Figure A030.5 – Back of the astrolabe (photo by S. R. Sarma)

INSCRIPTION

The inscription is engraved in outer band outside a shadow square with the base of 7:

ṣanᶜat aḍᶜaf al-ᶜibād muḥammad muqīm ibn ᶜīsā ibn allāhdād asṭurlābī lāhūrī humāyūnī

> 'The work of the least of the servants [of God], Muḥammad Muqīm, son of ᶜĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.'

To the right of the shadow squares is engraved the year of manufacture in both standard Arabic numerals and in *abjad* notation: *fī 1053 sanah hijrī gh-n-j* (in the year 1053 Hijrī). To the left of the shadow squares the year is mentioned in a different era: *fī 1955 sanah sikandarī gh-ẓ-n-h* (in the year 1955 of Alexander, i.e. Rūmī era).

The Hijrī year 1053 lasts from 21 March 1643 to 9 March 1644 and the Rūmī year 1955 from 11 October 1643 to 10 October 1944. Therefore, the astrolabe was completed in the period from 11 October 1643 and 9 March 1644.

A little below the Hijrī year is engraved *fī 1221 sanah* (in the year 1221). This cannot be the year of manufacture in a third era. It is obviously added by a latter hand and may probably refer to the year in Hijri era when a new owner acquired it in 1806-07.

PROVENANCE

Purchased by Lewis Evans in July 1909.

BIBLIOGRAPHY

Gunther 1932, no. 72, pp. 197-200, figs. 98 (plate for lat. 23°, wrongly labelled as 22°), 99 (front view), pl. XLVII (back & gazetteer).

A031 ASTROLABE BY MUḤAMMAD MUQĪM, AH 1053 (1643-44)[297]

Diameter 144 mm

Washington, National Museum of American History

CCA 86; Répertoire 16

COMPONENTS

Body with *kursī* (d. 144), shackle and ring, 5 plates, rete, alidade, pin and horse. Of these, the mater is original, the rete and the alidade are replacements, so also the plates serving the latitudes 31°-32° and 22°-25°.

FRONT

The ring is a corrugated circle and the shackle has the trifoliate shape. The *kursī* is covered on both sides with plates attached with rivets; apparently the fretwork is damaged. The limb is graduated in 1° and 5° and numbered 5—90; 5—90; 5—90; 5—90.

RETE

The rete is a crude replacement and non-functional.[298] The Capricorn ring is decorated with a pattern of a vine with leaves. The ecliptic is crudely divided and labelled with the names of the 12 signs. The name of only one star, *Qalb al-ᶜAqrab* (α Scorpii), is engraved near the tip of the Capricorn ring on the right.

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297 Entry based on Gibbs & Saliba 1984, pp. 129-132, where the gazetteer is not given. It is added here on the basis of a photo kindly provided by Dr Peggy Kidwell.

298 An astrolabe of 1659 by Muqīm's nephew Ḍiyā' al-Dīn (A076) is also equipped with a similar fake non-functional rete (cf. Gibbs & Saliba 1984, pp. 132-134; fig. 87).

Figure A031.1 – Rete of the astrolabe (photo courtesy National Museum of American History)

PLATES

There are 5 plates, each one notched at the north point.

Table A031-1 Plates

	φ	Longest Day
1a	Tablet of horizons	
1b	Tablet of ecliptic coordinates	
2a	36°	14 hours
2b	?	14 hours
3a	36°	14 hours
3b	40	14 hours
4a	31	14 hours
4b	32	14;8 hours
5a	25°	13 hours

	φ	Longest Day
5b	22°	13 hours

The first plate carries the tablet of ecliptic coordinates with the label *ṣafīḥat mīzān al-ᶜanka[b]ūt* on one side and the tablet of horizons on the other.

The other four plates are calibrated for different latitudes. Plate 3a is designed for latitude 36°, so is also plate 2a. The reverse side 2b carries no statement about the latitude. Strangely on all these plates, the duration of the longest day is given uniformly as 14 or 13 hours! For the latitude 32°, however, the correct value of 14;08 hours is given. It is also strange that there is no plate for the latitude of 27° (the Mughal imperial city of Agra) although a solar meridian altitude graph is drawn for this latitude on the back. Altitude circles are drawn for every 3° on some plates and for every 6° on some others; azimuth arcs for every 6° or 10°; similar variation occurs about the lines for equal hours.

Gibbs & Saliba opine that plates 4 and 5 are not original. But a closer examination is necessary to determine the original plates and the later additions.

Figure A031.2 – Geographical Gazetteer (photo courtesy National Museum of American History)

GEOGRAPHICAL GAZETTEER

The geographical gazetteer is engraved in three circles which are separated by blank rows with double lines on either side. It provides the names and coordinates of 77 localities, roughly according to increasing longitude. As in A026, the gazetteer here commences in the inner circle.

Table A031-2 Geographical Gazetteer

Locality	L	φ
Al-bilād	*al-ṭūl*	*al-*^{c}*arḍ*
Inner Circle		

	Locality	L	φ
1	Qayrawān	41;0	31;40
2	Ṭāᶜif	77;30	21;20
3	Madīnat Tayyaba	75;20	25;0
4	Makka Muᶜaẓẓam	77;10	21;40
5	Bayt al-Maqdis	66;30	31;50
6	Dimashq	70;0	33;15
7	Ḥalab	72;10	35;50
8	Marāgha	82;0	37;20
9	Tabrīz	82;0	38;0
10	Kūfa	79;10	31;30
11	Baghdād	80;0	33;25
12	Baṣra	84;0	30;11
13	Fīrūzābād	87;30	28;0
14	Shīrāz	88;0	29;36
15	Yazd	89;0	32;0
	Middle Circle		
16	Qazwīn	85;0	36;0
17	Iṣfahān	87;40	32;25
18	Kāshān	86;0	34;0
19	Bisṭām	89;30	36;10
20	Sabzawār	91;30	36;10
21	Mashhad	92;30	36;0
22	Harāt	94;20	34;30
23	Balkh	81;0	36;0

	Locality	L	φ
24	Badakhshān	104;24	37;10
25	Bukhārā	97;30	39;50
26	Samarqand	99;16	39;37
27	Khujand	100;35	41;55
28	Kāsghar	106;30	44;0
29	Khutan	107;0	42;0
30	Hurmūz	92/94;0	25;0
31	Maymand	101;55	33;20
32	Kirmān	91;30	30;5
33	Ghazna	104;20	33;35
34	Kābul	104;40	34;30
35	Purshūr	105;55	31;0
36	Tubbat	110;0	40;0
37	Kashmīr	108;0	35;0
38	Qandahār	107;40	33;0
39	Daybal	102;30	25;10
40	Bakar	105;0	27;40
41	Multān	107;35	29;40
42	Sālkūt	109;30	33;0
	Outer Circle		
43	Lāhūr	109;20	31;50
44	Tānīsar	112;33	30;10
45	Pānīpaht	113;20	28;52
46	Dihlī	113;35	28;39

	Locality	L	φ
47	Sanbhal	115;20	28;18
48	Sunām	112;25	30;30
49	Hānsī	112;25	29;45
50	Badāwan	114;59	27;32
51	Kūl wa Jalālī	114;19	28;4
52	Akbarābād	115;0	26;43
53	Kawāliyar	114;0	26;29
54	Qannawj	115;50	26;35
55	Karah wa Mānikbūr	118;10	29;49
56	Banāras	117;20	26;55
57	Jawnbūr	119;6	26;36
58	Kūpāmaū’	116;33	26;45
59	Barūj	111;5	21;20
60	Kālpī	116.45	26;55
61	Sarūj	72;40	34;50
62	Ajmīr	111;5	26;26
63	Ujjayn	110;50	23;30
64	Jidda	76;0	21;0
65	Awadh	118;6	27;22
66	Laknnaw	114;4	26;30
67	Narwar	114;0	25;20
68	Mandū	111;25	22;15
69	Burhānbūr	113;0	20;30
70	Ahmadābād	108;40	23;15

	Locality	L	φ
71	Kanbāyat	109;20	26;20
72	Dawlatābād	111;0	20;30
73	Juyūl	106;40	19;0
74	Sarāndīb	130;0	10;0
75	Sulṭānkūt	115;0	28;30
76	Bījāpūr	105;30	17;20
77	Kūlkanda	114;20	28;4!

BACK

On the back, the upper half of the rim carries the two altitude scales, divided in 1° and 5° and numbered as 5—90; 90—5 and the lower half of the rim the cotangent scales in feet and digits.

In the upper left quadrant is engraved a sine-cosine grid with 30 horizontal and 30 vertical parallels, every third line being highlighted. The upper right quadrant carries six declination arcs. Two graphs of solar meridian altitude are plotted on this quadrant for the latitudes 27° and 32° with the usual labels.

Figure A031.3 – Back of the astrolabe (photo courtesy National Museum of American History)

In the lower half, there are two shadow squares. The left one is divided in 12 digits and the right one in 7 feet, with appropriately numbered divisions and labels. Inside the area bounded by these two squares are semi-circles, the outer one contains the names of the 12 zodiac signs and the inner one the names of the 28 lunar mansions.

ALIDADE

The alidade is plain without any scales; it may also be a replacement.

INSCRIPTION

Above the semi-circle containing the names of the lunar mansions is engraved the name of the astrolabe maker. The date of production is written below the shadow squares.

> *ṣanaᶜahu muḥammad muqīm ibn ᶜīsā ibn allāhdād asṭurlābī humāyūnī lāhūrī fī sanah 1053 hijrī*
>
> 'Made by Muḥammad Muqīm, son of ᶜĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Empror] Humāyūn, in the year 1053 AH.'

BIBLIOGRAPHY

Gunther 1932, no. 86, p. 216.

Gibbs & Saliba 1984, pp. 129-132.

A032⊙ ASTROLABE BY MUḤAMMAD MUQĪM, AH 1070 (AD 1659-60)

Diameter 142 mm

London, British Museum (#1893,0616.4)

CCA 78; Répertoire 18

Figure A032.1 – Front of the astrolabe (@ Trustees of the British Museum)

The inscription on the lower rim on the back of this astrolabe proclaims that this astrolabe is made by Muḥammad Muqīm in AH 1070 (AD 1659-60). Even so, it raises some problems.

(i) There is a large gap of 17 years between Muqīm's last dated astrolabe of AH 1053 and this one. This can, of course, be explained away by saying that Muqīm continued making astrolabes but was not particular enough to put dates on the astrolabes.

(ii) The *kursī* is very low and not worked *à jour* as in all other astrolabes by Muqīm.

(iii) The inner side of the mater where the gazetteer is engraved and three plates have silver finish which is unusual.

(iv) On the rete the equinoctial and the solstitial bars are graduated.

(v) The most problematic is the geographical gazetteer. The symbol used here for zero, resembling a pair of small scissors (see Figure A032.5), is unlike the symbol in all other astrolabes by Muqīm. His nephew Ḍiyā' al-Dīn uses this symbol most frequently. Did Ḍiyā' al-Dīn then engrave the gazetteer? As in Muqīm's astrolabes A024 and A030, the gazetteer is arranged here according to climates. After the end of the seventh climate, five places are listed under the heading *iqlīm khāriz,* 'beyond climate,' implying 'beyond the seventh climate'. These are Allahabad, Surat, (?), Dhaka and Patna, i.e., Indian cities which should have been mentioned in the second climate. Furthermore, in the headings *iqlīm* and *iqlīmhā* are used indiscriminately.

COMPONENTS

Body with *kursī* (d.142, h. 176, t. 6), shackle and ring, rete, 4 plates, alidade, pin and horse. One plate is a replacement, so too are the alidade, pin and horse.

FRONT

The ring is large and the shackle has a trifoliate shape. The *kursī* is very low and solid. The profiles are made up of many lobes and decorative holes. The surface is engraved with a floral motif in bas relief. The finial is trifoliate.

The limb is divided in 1° and 5° and labelled 5—90; 5—90; 5—90; 5—90.

Figure A032.2 – Rete of the astrolabe (@ Trustees of the British Museum)

RETE

The two rings of the Tropic of Capricorn and ecliptic are held together by complete equinoctial and solstitial bars without any counter change. The left edge of the solstitial bar and the upper edge of the equinoctial bar constitute the vertical and horizontal diameters respectively. Like the edge of the ecliptic circle, these edges are also sloping; they are also graduated, into certain number of units and labelled with *abjad* numbers. Each division is subdivided into 3 parts. The star pointers are joined by a fine floral tracery.

There is handle at 45° off the meridian in NW. On the back of the rete is engraved *ṣāḥib* (صاحبه) upside down at the bottom of the ecliptic ring. Is this an incomplete attempt to engrave the name of the owner?

PLATES

There are four plates, all with silver finish. The last one is made of a lighter metal and the projections on it are not complete; it must be a replacement.

Table A032-1 Plates

	φ	Longest Day
1a	25°	13;25 hours
1b	27°	13;43 hours
2a	29°	13;52 hours
2b	32	14;8 hours
3a	Tablet of ecliptic coordinates	
3b	Tablet of horizons	
4a	9°	---
4b	11°	12;20 hours

On plates 2 and 3 altitude circles are drawn for every 2°; every second one is labelled as 4, 8, …, on both sides.

On 2a, there are no azimuth curves; on 2b, 3a-b, azimuth curves are drawn for every 6° below the horizon, numbered in a straight line below the Tropic of Cancer.

On plates 2 and 3, lines for seasonal hours and dotted lines for equal hours from the western horizon are drawn; both sets are numbered jointly from 1 to 12 from the western horizon onwards.

Plate 2a has an additional feature: here plain lines are drawn for *ghaṭīs* from the western horizon and counted from 1 to 31 in standard Arabic/Persian numerals.

Plate 3a is inscribed with the tablet of ecliptic coordinates and carries the label *ṣafīḥat mīzān al-*^{c}*ankabūt.* Latitude circles are drawn for every 3°; they are labelled on alternate sides of the vertical diameter from the centre to the north point. Every fifth line (15°) is dotted. Longitude circles are traced for every 6°; the circles for every 30°, being the boundaries of the signs, are dotted. In the lower half the sign names and numbers of the divisions (6, 12, … 30) are inscribed below the ecliptic circle; but in the upper half, these are not written below the upper half of the ecliptic but (much below) just above the equator circle. Under the east west diameter are written *al-mashriq* in the east and *al- maghrib* in the west.

Plate 3b carries the Tablet of horizons and has the label *ṣafīḥa āfāqiyq*. It carries four sets of half horizons for each degree of latitude, from 10° to 66° (the last one repeated in all the sets), but each alternate latitude numbered at both extremities.

11	19	27	35	43	51	59	66
12	20	28	36	44	52	60	66
13	21	29	37	45	53	59	66
14	22	30	38	46	54	60	66

Declination scales along the four radiallines; these are divided into 2 and 6 units and labelled as 6, 12, 18, 24.

The fourth plate, which appears to be a later addition, is calibrated for latitude 9°. Here are drawn altitude circles for every 5°, and labelled on both sides. There are no azimuth arcs. The reverse side, 4b, is made for the latitude 11°. Here also altitude circles are traced for every 5° and labelled on both sides. There are no azimuth arcs, nor lines for seasonal hours. Lines for equal hours are drawn from the western horizon and numbered from 1 to 12.

Figure A032.3 – Geographical gazetteer (@ Trustees of the British Museum)

GEOGRAPHICAL GAZETTEER

The gazetteer is engraved in three circles with three rows in each to provide the coordinates of 93 localities arranged according to climates. The writing in upside down, but the enumeration begins in the outer circle.

Table A032-2 Geographical Gazetteer

	Place Name *asmā' al-buldān*	**L** *al-tūl*	**φ** *al-ᶜarḍ*
	Outer Circle		
[-I] *iqlīm* (!) *az khaṭṭ istiwā' tā iqlīm awwal* (from the line of equator up to the first climate)			
01	(Sāhil Bahr Awqiyānus)	11;0	0;0
02	(Jazīrah Qabala)	----	3;0
03	Jamkūt	177;0	5;0
04	Shallā	170;0	5;0
05	Kūkūh	54;10	10;0
06	ᶜAdan	76;0	11;0
07	?	10;0	14;0
08	Dabal	74;20	14;10
09	?	77;30	14;30
10	Jind	75;30	14;30
[I] *al-iqlīm awwal* (the first climate)			
11	Sawmnāt	104;0	17;0
12	Zaitūn?	114;0	17;15
13	Bijāpūr	105;30	17;20
14	Burhānpūr	103;0	20;30
[II] *iqlīmhā* (!) *al-iqlīm dūyam* (the second climate)			

	Place Name *asmā’ al-buldān*	L *al-tūl*	φ *al-ᶜarḍ*
15	Dawlatābād	111;0	20;30
16	Jidda	77;0	21;0
17	Ṭāᶜif	77;30	21;20
18	Makka Muᶜẓẓum	77;10	21;40
19	Kanbayāt	109;20	22;20
20	Khaybar	75;20	24;20
21	Madīnat Musharrafa 75;20	25;0	
22	Hurmūz	92;0 !	25;0
23	Ajmīr Haḍrat Khwājā	111;0	26;0
24	Kawālīyar	114;0	26;29
25	Lahknūtī	114;33	26;30
26	Qannawj	115;50	26;35
27	Jawnpūr	119;6	26;36
28	Akbarābād dār al-Mulk Hind	114;0	26;43
29	Kūbāmaū’	116;33	26;45
30	Karah wa Mānikpūr	118;10	26;49
31	Awdah	118;6	27;22
32	Badāwan	119;19	27;22
[III] *iqlīmhā* (!) *al-iqlīm siwum* (the third climate)			
33	Kūlkanda	114;19	18;4
34	Fīrūzābād	106;30	28;20
35	Shāhjahānābād	113;35	28;39

	Place Name *asmā' al-buldān*	L *al-ṭūl*	φ *al-ʿarḍ*
36	Shīrāz	108;0	29;36
37	Multān	107;35	29;40
38	Baṣra	84;0	30;0
39	Miṣr	66;20	30;20
	Middle Circle		
[III] *tatimma iqlīm siwum* (continuation of the third climate)			
40	Kūfa	79;30	31;30
41	Bayt al-Maqdis?	66;30	31;30
42	Lāhūr dār al-Saltanat	109;20	31;50
43	Yazd	89;0	32;0
44	Iṣfahān	87;40	32;25
45	Qandahār	104;40	33;0
46	Sālkūt	109;0	33;0
47	Madā'in	72;0	33;0
48	Dimashq	70;0	33;55
49	Baghdād	72;0	33;25
[IV] *iqlīm chahārum* (fourth climate)			
50	Kāshān	86;0	34;0
51	Mawṣil	77;0	34;30
52	Tūn	92;30	34;30
53	Harāt	94;30	34;30
54	Kābul	104;40	34;30
55	Rayy	86;20	35;20

	Place Name *asmā' al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*
56	Kashmīr ?	108;0	35;0
57	Hamadān	83;0	35;10
58	Ḥalab	72;10	35;50
59	Mashhad Maqdis	92;30	36;0
60	Sabzawār	91;30	36;?
61	Balkh	101;0	36;41
62	Badakhshān	84;24	37;10
63	Tabrīz	82;0	38;0
64	Ardabīl	82;0	38;0
65	Nakhajwān	81;15	38;40
[V] *iqlīmha* (!) *al-iqlīm panjum* (the fifth climate)			
66	Samarqand	99;16	39;37
67	Bukhārā	97;30	39;50
68	Tubbat	110;0	40;0
69	Bardaᶜa	83;0	40;30
70	Samākhī	84;30	40;50
	Inner Circle		
[V] *tatimma iqlīm panjum* (continuation of the fifth climate)			
71	--	66;30	41;0
72	Khujand	105;35	41;55
73	Khutan	107;0	42;0
74	Kāshān	101;35	42;0
75	Farghāna	102;0	42;20

	Place Name	L	φ
	asmā' al-buldān	***al-tūl***	***al-ᶜarḍ***
[VI] *iqlīm shashum* (sixth climate)			
76	Kāshghar	106;30	44;0
77	--	92;0	44;0
78	Balkh		
79	Ṭarāz		
80	Bīsh Bāligh	46;0 ?	
81	Khān Bāligh		
82	Harat		
[VII] *iqlīm haftum* (seventh climate)			
83	Arq	105	70;0
84	Bulghār	60;0	?;30
85	?		
86	Qirqir	64;30	50;40
87	Kirmān Mārī	65;45	50;45
88	Ṣūdaq	66;0	51;0
[VII+] *iqlīm khāriz* (beyond climate)			
89	Allāhābād	115;34	26;50
90	Sūrat	108;50	13;15 ?
91			
92	Dhāka Bankāla	130;0	?
93	Patna	120;?	

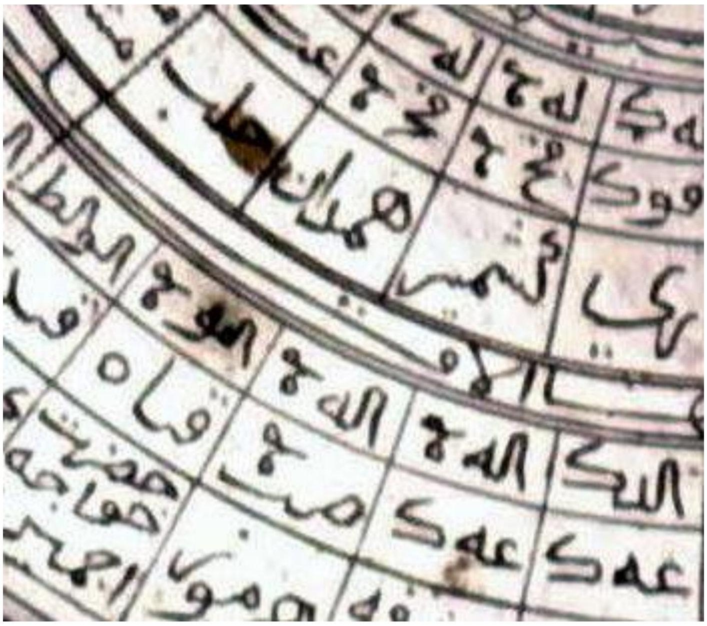

Figure A032.4 – Detail of Figure A032.3 showing the zero symbols

Figure A032.5 – Back of the astrolabe (@ Trustees of the British Museum)

BACK

On the back, the upper half of the rim carries altitude scales, divided in 1° and 5° and labelled 5—90; 90—5.

In the upper left is the trigonometric quadrant with 60 horizontal parallels. The solar quadrant in the upper right divided into 18 zones by the declination curves. Along the two radii are engraved the names of the corresponding signs and the degrees of their subdivisions (10°, 20°, 30°). Four sigmoid curves are drawn here to represent the midday altitude of the sun throughout the yeat at four latitudes 27° (Agra), 29° (Delhi), 32° (Lahore), 36° (Samarqand). The uppermost curve carries the label *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27.* For the others, just the numerical value of the latitude is engraved below on the right hand side. In all other astrolabes Muqīm drew just two curves for the latitudes of 27° (Agra) and 32° (Lahore). In this astrolabe a curve was added for the latitude 29° (Delhi), presumably because in 1648 Shah Jahan shifted the Mughl capital from Agra to Delhi and renamed the latter as Shāhjahānābād.[299]

In the lower half of the back are shadow squares, on the left for the base of 12 digits and on the right for the base of 7 feet, with the usual labels.

Inside the shadow squares, there are two rectangular tables. On the right is the table of multiples of the differences between the approximately correct length of the tropical year and 365 days (*faḍl al-dawr*). On the left is the table of the triplicities and their regents of the night and of the day with the heading *jadwal arbāb muthallathāt laylī wa nahārī.* This table differs slightly from the tables in other astrolabes.

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[299] Muqīm's nephew Ḍiyā' al-Dīn drew two curves for the latitudes of 27° and 32° in his astrolabes made before 1648 and three curves for 27°, 29° and 32° in the astrolabes produced after 1648.

Table A032-3 Triplicities and Regents

Night Regent	Sign	Day Regent		Night Regent	Sign	Day Regent
Jupiter	Aries	Sun		Mercury	Gemini	Saturn
Sun	Leo	Jupiter		Saturn	Libra	Mercury
Saturn	Sagittarius	Saturn		Jupiter	Aquarius	Jupiter
Moon	Taurus	Venus		Venus[300]	Cancer	Venus
Venus	Virgo	Moon		Mars[301]	Scorpio	Mars
Mars	Capricorn	Mars		Saturn[302]	Pisces	Saturn[303]

Outside the shadow squares are six semi-circular rows; the first two outer ones display the relation between the 28 lunar mansions and 12 signs of the zodiac. The next two rows contain the tables of limits (*ḥudūd*) and the last two the decans (*wuzūh*) and their regents.

The rim of the lower half contains cotangent scales in digits and feet respectively. On the middle of this row is engraved the maker's signature and date.

ALIDADE

The alidade is plain and uninscribed. It appears to be a replacement added later.

INSCRIPTION

It appears that while designing the back, no plan was made for the location of the inscription. After the back has been completely engraved, including the cotangent scales and the numbers of the division on them, the inscription was engraved there as an afterthought. In the cotangent tables, the first cells on either side of the meridian line are

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300 Elsewhere Mars.

301 Eslewhere Venus.

302 Elsewhere Moon.

303 Elsewhere Moon.

rather long with just the numerical value 6 (و) engraved there. The inscription was placed here, with the numerical value 6 (و) punctuating it on both sides of the meridian:

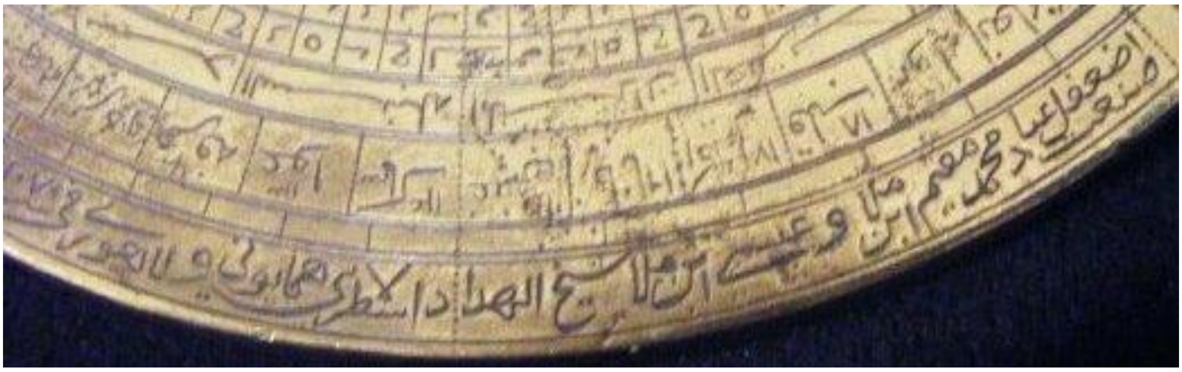

Figure A032.5 – Signature of the astrolabe maker (detail of Figure A032.4)

ṣan^c^at aḍ^c^af al-^c^ibād muḥammad muqīm ibn mullā [و] ^c^īsā ibn mullā shaykh allāhdād asṭurlābī humāyūnī [و] lāhūrī fī sanah 1070 hijrī

'Made by the weakest of the servants [of God], Muḥammad Muqīm, son of Mullā cĪsā, son of Mullā Shaykh Allāhdād of Lahore, astrolabe maker to [the Emperor] Humāyūn in 1070 Hijrī [= 1659-60].'

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A033 ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED[304]

Diameter 270 mm

Paris, PC (Georges Charliat)

CCA 3504; Répertoire 23

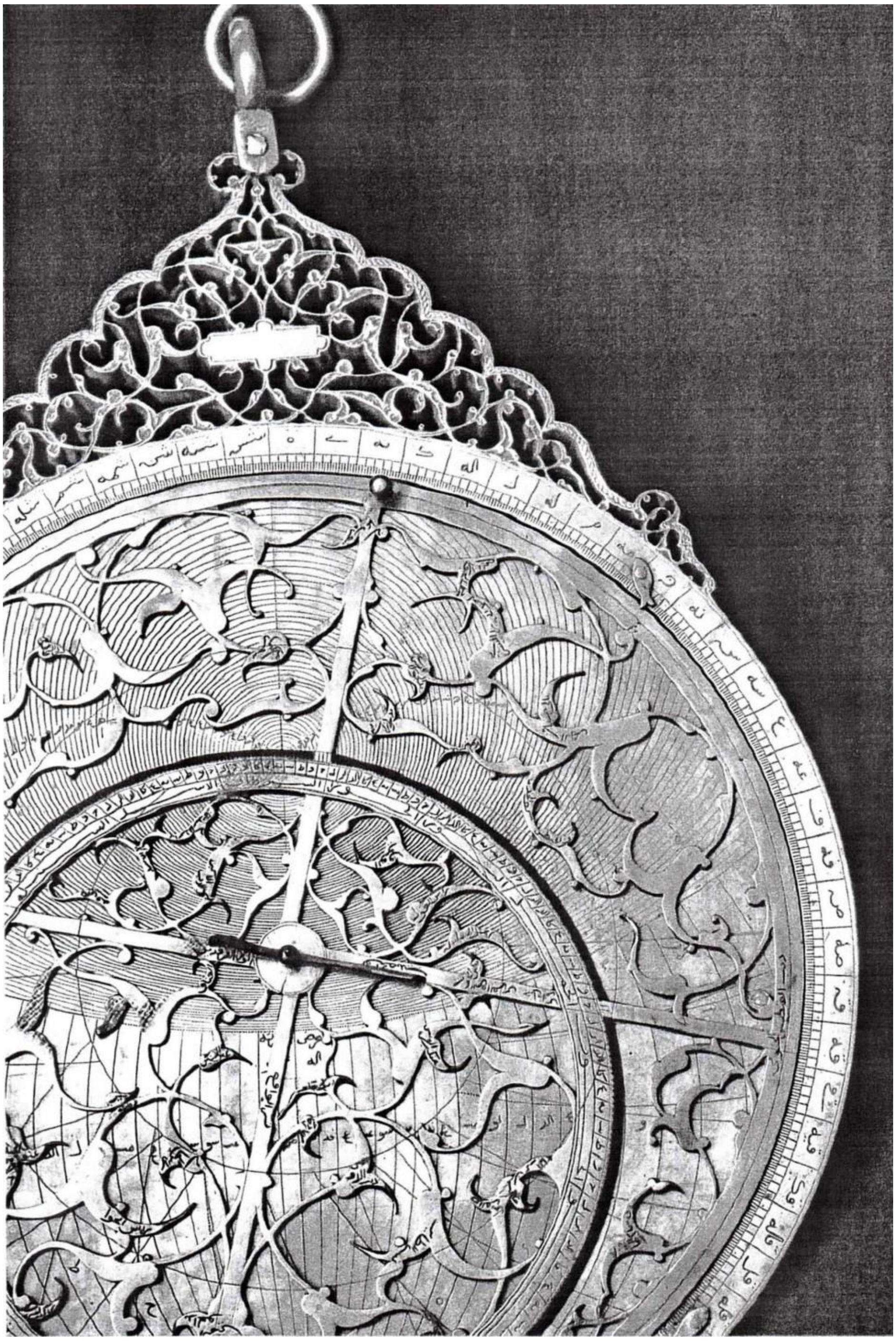

Figure A033.1 – Front of the astrolabe (photo from Guye & Michel 1971)

[304] Entry based on the Répertoire (23) and a partial photo in Guye & Michel 1971, fig. 211.

From the partial image published in Guye & Michel, the astrolabe appears to be a large and splendidly crafted piece. According to the Répertoire, it is one of the rare astrolabes to have an eccentric zodiac calendar on its back.[305]

COMPONENTS

Body with *kursī,* shackle and ring, rete for 44 stars, pin and wedge; no information is available on the number of the plates and on the alidade.

FRONT

The very delicately fretted *kursī* looks like filigree work, with the motif of the tulip with flared petals is repeated often. The profiles, with lobes between ogees above and below are engraved with a pattern on the surface. The trifoliate finial is also fretted. There is a cartouche in the centre of the *kursī.*

The limb is divided in 0;20°, 1° and 5° and labelled from 5 to 360. The inner edge of the limb is not straight, but is rather irregular which is surprising.

RETE

The Capricorn ring and the ecliptic ring are held together by the complete equinoctial and solstitial bars, each with a counter change at the centre. The ecliptic ring is divided into the 12 zodiac signs and labelled with their names. Each sign is further subdivided into units of 3° and numbered accordingly. The star pointers are joined by a delicate floral tracery where once again the motif of tulip flowers two flared petals dominates. There is a handle at the north point. On the limb, at 50° and 140° can be seen two small fish-shaped rotatable lugs to hold the rete in place. Presumably there are two more such clips at 230° and 320°, that it at an interval of 90°.[306]

PLATES

It is not known how many plates there are. In the only available photo, beneath the rete can be seen a plate carrying stereographic projections for latitude 25°. Here altitude circles are drawn for every 1° and azimuth arcs for every 6° below the horizon. There

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305 Qā'im Muḥammad's astrolabe of 1635 (A013) also has a such a calendar on the back.

306 Similar clips can be seen in an astrolabe (A104) attributable to Ḍiyā' al-Dīn Muḥammad at the Adler Planetarium, Chicago.

are two sets of hour lines, one for seasonal hours and the other for equal hours since sunset and before sunrise.

Geographical Gazetteer

A geographical gazetteer is engraved on the inner side of the mater.

Back

On the back, the upper half of the rim carries the two altitude scales divided in 1° and 5° and labelled 1— 90; 90— 1. There is an eccentric zodiac calendar divided in 12 x 30 units and also a calendar of Syrian months divided in 28, 30, 31 days. There are the usual trigonometric quadrant in the upper left, the solar quadrant in the upper right, shadow squares in the lower half, besides a table of triplicities and other astrological tables.

Inscription

> ^{c}*amal bi-yad aḍ*^{c}*af al-*^{c}*ibād muḥammad muqīm ibn mullā* ^{c}*īsā ibn shaykh allāhdād asṭurlābī humāyūnī lāhūrī*
>
> ‘Made by the hand of the weakest of the servants [of God], Muḥammad Muqīm, son of Mullā ^{c}Īsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.’

Bibliography

Guye & Michel 1971, pp. 226, 228, fig. 211, where a partial image of the front is published.

A034 ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED

Diameter 206 mm

Paris, PC

CCA 3828; Répertoire 22

The only information available is from the Répertoire. According to this source, the astrolabe consists of the body, rete for 40 stars and 5 plates. A geographical gazetteer is engraved on the inner side of the mater.

On the back, the rim of the upper half carries two altitude scales. On the upper left there is a trigonometric quadrant and on the upper right a solar quadrant with curves for the midday altitude of the sun at latitudes 27° and 32°. In the lower half, shadow squares, table of triplicities and other astrological tables.

INSCRIPTION

aḍa^c^f al-^c^ibād muḥammad muqīm ibn ^c^īsā ibn allāhdād
asṭurlābī humāyūnī lāhūrī

'[Made by] the weakest of the servants [of God], Muḥammad Muqīm, son of ^c^Īsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.'

PROVENANCE

The astrolabe was previously in the collection of Nicholas Landau, Paris.

A035 ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED[307]

Diameter 204 mm

Paris, PC

CCA 3829

COMPONENTS

Body, rete for 43 stars, 4 plates; no information on alidade, pin and horse.

FRONT

The limb is divided in 1° and 5° and numbered from 5° to 360°.

RETE

The following 46 stars named on the pointers in the rete

Table A035-1 Stars on the Rete

	Star Name	Identification
01	*Dhanab Qayṭus J[anūbī]*	β Ceti
02	*Baṭn*	β Andromedae
03	*Dhanab al-Ḥūt*	α Piscium
04	*Rijl al-Musalsala*	γ Andromedae
05	*Ṣadr al-Qayṭus*	π Ceti
06	*Ghūl*	β Persei
07	*Kaff al-Jadhmā'*	α Ceti
08	*Tālī Musāfat al-Nahr*	γ Eridani
09	*ᶜAyn al-Thawr*	α Tauri
10	*Al-ᶜAyyūq*	α Aurigae
11	*Rijl Yusrā*	β Orionis
12	*Yad al-Jawjā' Yusrā*	γ Orionis

[307] Entry based on an unpublished description kindly provided by Prof. David King.

	Star Name	Identification
13	*Yad al-Jawzā’ Yumnā*	α Orionis
14	*Rijl al-Jawzā’ Yumnā*	κ Orionis
15	*Shi*^{c}*rā Yamānī*	α Canis Majoris
16	*Shi*^{c}*rā Shāmī*	α Canis Minoris
17	*Ṭarfat al-Safīnā*	ρ Puppis
18	*Minkhar al-Shujā*^{c}	σ Hydrae
19	*Fard al-Shujā*^{c}	α Hydrae
20	*Qā’idat al-Bāṭiya*	α Crateris
21	*Ẓahr al-Dubb al-Akbar*	α Ursae Majoris
22	*Janāḥ al-Ghurāb*	γ Corvi
23	*Al-*^{c}*Anāq*	ζ Ursae Majoris
24	*Simāk A*^{c}*zal*	α Virginis
25	*Simāk Rāmiḥ*	α Bootis
26	^{c}*Unuq al-Ḥayya*	α Serpentis
27	*Qalb al-*^{c}*Aqrab*	α Scorpii
28	*Rukbat al-Ḥawwā’ Yusrā*	ζ Ophiuchi
29	*Rās al-Jāthī*	α Herculis
30	*Rās al-Ḥawwā’*	α Ophiuchi
31	^{c}*Ayn al-Tinnīn*	γ Draconis
32	*Yad al-Ḥawwā’ Yumnā Muqaddam*	δ Ophiuchi
33	*Nasr al-Wāqi*^{c}	α Lyrae
34	*Minqār al-Dajāja*	β Cygni
35	*Nasr Ṭā’ir*	α Aquilae
36	*Dhanab al-Dulfīn*	ε Delphini

	Star Name	Identification
37	*Ridf*	α Cygni
38	*Dhanab al-Jadī*	δ Capricorni
39	*Fam al-Faras*	ε Pegasi
40	*Sāq-i Sākib al-Mā' J[anūbī]*	δ Aquarii
41	*Mankib al-Faras*	β Pegasi
42	*Kaff al-Khaḍīb*	β Cassiopeiae
43	*Surrat al-Faras*	δ Pegasi

PLATES

There are four plates with the following specifications:

Table A035-2 Plates

	φ	Longest Day
1a	18°	13;9 hours
1b	22°	13;-- hours
2a	23;30°	13;30 hours
2b	25°	13;-- hours
3a	45°	15;-- hours
3b	0° + 72°	
4a	Tablet of horizons	
4b	Tablet of ecliptic coordinates	

On plates 1-3a, altitude circles are drawn for each 2° and azimuth arcs for each 6° above or below the horizon as well as curves for the hours since sunset or hours before

sunrise. On plate 3b, altitude circles are for every 3° and azimuth arcs for every 6°. Two original plates are missing; one of them was replaced by 4.

Geographical Gazetteer

There is a geographical gazetteer engraved inside the mater.

Back

On the back, the rim of the upper half carries two altitude scales divided in 1° and 5° and marked 5 — 90; 90 — 5. On the upper left is a trigonometric quadrant and on the upper right a solar quadrant with curves for the midday altitude of the sun at latitudes 27° and 32°.

Provenance

The astrolabe was previously in the collection of Nicholas Landau, Paris.

A036 ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED[308]

Diameter 160 mm

Lahore, Lahore Museum (#M.44-1)

Répertoire 19

Figure A036.1 – Front of the astrolabe (photo courtesy Dr Naseem Naqvi)

[308] Entry based on photos kindly provided by Dr Naseem Naqvi, London, and photos and detailed information kindy sent by Mubashir Ul-Haq Abbasi, Islamabad. Mubashir Ul-Haq Abbasi will be publishing a full-length description shortly.

Components

Body with *kursī* (d. 160, h. 205, t. 12), rete for 31 stars and 5 plates. The ring, shackle, alidade, pin and wedge are missing. The ensemble is held together by a modern bolt and nut.

Front

The *kursī* is not pierced; its surface on both sides is decorated with a very fine design of intertwining creepers and flowers in low relief. The trifoliate finial is pierced with a small hole at the base on each side, as is done in Kufic astrolabes and also in Muqīm's own astrolabes A047 and A048. The degree scale on the rete is divided in 1° and 5° and numbered from 5 to 360.

Figure A036.2 – Rete of the Astrolabe (photo by Mubashir Ul-Haq Abbasi)

Rete

The rete in this astrolabe resembles the same in the astrolabe of 1567 by Allāhdād (A001) and in the astrolabe attributable to Allāhdād (A004); thus it does not follow the characteristic style of the Lahore astrolabes. The Capricorn ring and the ecliptic ring are

held together by the equinoctial bar and the complete solstitial bar, both of which are counter-changed at the centre. Large arcs of the circle representing the equator are shown both within and below the ecliptic. There are 31 star pointers on the rete which exhibit an archaic form of tiger's claws. A handle affixed in the Capricorn ring, to the right of the north point, is now lost; just a hole remains there.

Table A036-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
2	*Baṭn al-Ḥūt*	β Andromedae
3	*Rijl al-Musalsala*	γ Andromedae
4	*Fam al-Qayṭus*	γ Ceti
5	*Ghūl*	β Persei
6	*ᶜAyn al-Thawr*	α Tauri
7	*ᶜAyyūq*	α Aurigae
8	*Rijl al-Jawzā' Yusrā*	β Orionis
9	*Yad al-Jawzā' Yumnā*	α Orionis
10	[*Shiᶜrā Yamānī*][309]	α Canis Majoris
11	*Shiᶜrā Shāmī*	α Canis Minoris
12	*Minkhar Shujāᶜ* (?)	σ Hydrae
13	*Fard Shujāᶜ*	α Hydrae
14	*Qalb al-Asad*	α Leonis
15	*Ẓahr al-Asad*	δ Leonis
16	*Ṣarfa*	β Leonis
17	*Janāḥ al-Ghurāb*	γ Corvi

309 A curved star pointer was made but not labelled.

	Star Name	Identification
18	*Al-ᶜAnāq*	ζ Ursae Majoris
19	*Simāk Aᶜzal*	α Virginis
20	*Simāk Rāmiḥ*	α Bootis
21	*Nayyir Fakka*	α Coronae Borealis
22	*ᶜUnuq al-Ḥayya*	α Serpentis
23	*Al-Jāthī*	α Herculis
24	*Nasr Wāqiᶜ*	α Lyrae
25	*Miqār [Da]jāja*	β Cygni
26	*Nasr Tā'ir*	α Aquilae
27	*Dhanab al-Dālfīn* (!)	ε Delphini
28	*Dhanab al-Jadī*	δ Capricorni
29	*Mankib Faras*	β Pegasi
30	*Sāq Sākib al-Mā J[anūbī]*	δ Aquarii
31	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are five plates in the astrolabe.

Table A036-2 Plates

	φ	Longest day
1a	21;40°	13 hours
1b	24°	13 hours
2a	27°	13;43 hours
2b	31;50°	14;7 hours
3a	36°	14;00

	φ	Longest day
3b	40°	14;00
4a	45°	--
4b	34;20°	14;00
5a	Tablet of Ecliptic coordinates	
5b	Tablet of Horizons	

On all these plates (except 5a), altitude circles are drawn for each 3° with every fifth circle dotted, azimuth arcs for each 10° below the horizon, and plain lines for seasonal hours and dotted lines for equal hours drawn from the western and eastern horizons. All these sets of lines are numbered. On the plate for 45°, the duration of the longest day is not mentioned.

On the tablet of ecliptic coordinates, latitude circles are drawn for each 6° and longitude circles for each 10°, with every third circle which forms the boundary between the signs being dotted. The two sets of circles are numbered. The names of the signs are written along the ecliptic. Plates 1 to 4 have notches at the north point. Plate 5 has notches at all the four compass points. This is one of the few cases where four notches are made, although every plate containing the tablet of horizons ought to have them, so that the four sets of half horizons can be made use of.

Figure A036.3 – Geographical gazetteer (photo by Mubashir Ul-Haq Abbasi)

GEOGRAPHICAL GAZETTEER

On the inner surface of the mater is engraved a geographical gazetteer in two circles, with much empty space in between, for 70 places arranged roughly according to increasing longitude, starting from Qayrawān in modern Tunisia and proceeding eastwards. In the upper row of each circle are given the longitudes, in the middle row the place names and in the lower row the latitudes. In reproducing the data in the following table, we follow a uniform order of place name first and longitude and latitude thereafter.

Table A036-3 Geographocal Gazetteer

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
	First Circle		
1	Qayrawān	41;0	31;40
2	Mahdiyya	42;0	32;0
3	Miṣr	63;20	20;20
4	ᶜAdan	76;0	11;0
5	Madīnaat Tayyaba	75;20	25;0
6	Makka Munajjam	77;10	21;40
7	Ṭā'īf	77;30	21;20
8	Bayt al-Maqdis	66;30	31;50
9	Dimashq	70;0	33;15
10	Ḥalab	72;10	35;50
11	Qūniya	66;30	41;0
12	Raqqah	73;15	36;0
13	ᶜĀna	76;30	34;0
14	Tabrīz	82;0	38;0
15	Bardaᶜa	83;0	40;30
16	Kūfa	79;30	31;30
17	Madā'īn	72;0	33;10
18	Baghdād	80;0	33;25
19	Baṣra	84;0	30;0
20	Fīrūzābād	87;30	28;10
21	Shīrāz	83;0	29;36
22	Yazd	89;0	34;40

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ʿarḍ*
23	Hamadān	83;0	35;10
24	Sāwa	85;0	35;0
25	Qazwīn	85;0	36;0
26	Iṣfahān	86;40	32;25
27	Kāshān	86;0	34;0
28	Qumm	85;40	34;45
29	Rayy	86;20	35;0
30	Astarābād	89;35	36;50
31	Sabzawār	91;30	36;0
32	Nayshābūr	92;30	36;21
33	Mashhad	92;30	36;0
34	Tūn	92;30	34;30
35	Qā'īn	93;20	33;40
36	Harāt	94;20	34;30
37	Marw	97;0	37;40
38	Balkh	101;0	36;41
39	Badakhshān	104;27	37;10
40	Bukhārā	97;30	39;50
41	Samarqand	99;16	39;37
42	Khujand	100;35	41;15
43	Kashghar	106;30	44;0
44	Khutan	107;0	42;0
45	Hurmūz	92;0	25;0
46	Kirmān	91;30	30;0

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ʿarḍ*
47	Ghazna	104;20	33;35
	Second Circle		
48	Kābul	104;40	34;30
49	Daybul	102;30	25;10
50	Bakar	105;0	37;40
51	Qandahār	107;40	33;0
52	Tubbat	110;0	40;0
53	Kashmīr	108;0	35;0
54	Multān	107;35	29;40
55	Lāhūr	109;20	31;50
56	Tānīsar	112;33	30;10
57	Haḍrat Dihlī	113;25	28;39
58	Akbarābād	115;4	26;43
59	Qannawj	115;50	36;35
60	Banāras	1[1]7;20	26;55
61	Kawāliyar	114;0	26;29
62	Jawnbūr	119;50	26;36
63	Ajmīr	111;5	26;0
64	Jadda	77;0	21;0
65	Ujjayn	1[1]2;0	22;30
66	Burhanbūr	1[1]3;0	20;30
67	Bījābūr	105;30	16;20
68	Kūlkanda	114;19	18;4
69	Kanbāyat	109;4	22;20

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
70	Sarāndīb	130;0 (!)	10;0

BACK

The upper half of the rim on the back carries the altitude scales which are divided in 1° and 5° and numbered 5—90; 90—5. In the upper left is the trigonometric quadrant with 60 horizontal parallels, with each fifth highlighted with dots. Opposite to it is the solar quadrant with declination arcs, one for each 10° of solar longitude. Here each third circle, which forms the boundary between two signs, is dotted. The names of the related signs are engraved along the two radii, together with the degrees of each decan as 10, 20, 30, marked separately for each sign. Two graphs solar meridian altitude at the latitudes of 27° and 32° are plotted in this quadrant along with the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ* 32 respectively.

In the lower half are the shadow squares, on the left for a base of 7 feet and on the right for a base of 12 digits. The vertical and horizontal scales are divided and numbered accordingly. On the two lower corners there is a label each reading *ẓill sullam,* (the scale of shadows). The 4 scales are accompanied by the following labels:

Vertical scale on the left: *ẓill aṣābiᶜ maᶜkūs*
Horizontal scale on the left: *ẓill aṣābiᶜ mustawī*
Horizontal scale on the right: *ẓill aqdām mustawī*
Vertical scale on the right: *ẓill aqdām maᶜkūs.*

The space inside the shadow squares is occupied by 7 concentric semi-circular rows. The first and the outermost row carries the names of the 28 lunar mansions and the second row the names of the 12 corresponding zodiac signs. Rows 2, 3, 4 constitute a table of the decans (*wujūh*) and their regents. Rows 2, 5, 6, 7 form a table of the triplicities and their diurnal and nocturnal regents.

The shadow squares are encircled by 5 concentric semi-circular rows. The first and the outermost row on the rim carry the cotangent scales, on the left in feet and on the right in digits as in the shadow squares. The unequal divisions on the scale on the left are numbered, starting from the south-north line, as 5, 7, 10, 15, 20, 25, 30, 36, 42,

48, 54, 60, followed by the label *al-aqdām* (feet). The unequal divisions on the scale on the right are numbered, also from the south-north line, as 5, 10, 12, 15, 20, 25, 30, 36, 42, 48, 54, 60, followed by the label *al-aṣābi*^{c} (digits). These divisions are subdivided into 5 in the following semi-circular row.

Rows 3, 4, 5 contain a table of limits (*ḥudūd*), with the names of the signs in the fifth row.

Inscription[310]

Immediately below these 5 semi-circular rows is the astrolabe maker's signature, inscribed on both sides of the south-north line:

> *ṣana*^{c}*ahu muḥammad muqīm ibn* ^{c}*īsā ibn allāhdād*
> *asṭurlābī humāyūnī lāhūrī*
> 'Made by Muḥammad Muqīm, son of ^{c}Īsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.'

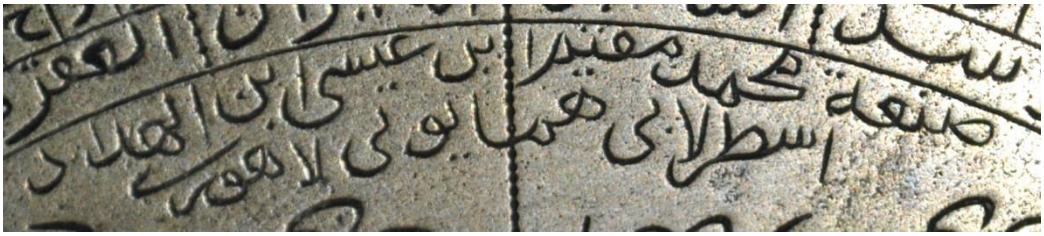

Figure A036.4 – Signature of the astrolabe maker (photo by Mubashir Ul-Haq Abbasi)

On the edge of the mater, there is yet another inscription, this time providing the name of an owner, which reads:

> *mālik aqall al-*^{c}*ibād muḥammad hāshim ibn muḥammad bāqir tabrīzī*
> 'Owner, the weakest of the servants [of God], Muḥammad Hāshim, son of Muḥammad Bāqir, of Tabrīz.

Provenance

Donated to the Museum by Masud Ilahi in memory of his father Shaikh Mahbub Ali, an agricultural engineer from Faisalbad and a former member of the Constituent Assembly, India.

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310 The Répertoire does not give the text, but only the translation which is somewhat off the mark: 'Made by Muḥammad Muqīm, son of ^{c}Īsā, son of Allāhdād, in the reign of the emperor Shāh ad-Dīn[!] Shāh Jahān[!].

Bibliography

Dar 1994, pp. 169-172, pls. II-V.

A037 ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED[311]

Diameter 146

PLU: ex-Canada, Don Mills, Ontario Science Centre (#68.165.1)

CCA 3827; Répertoire 25

Figure A037.1 – Front of the astrolabe (photo courtesy Ontario Science Centre)

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311 This entry is based on a full set of photocopies made directly from the astrolabe parts and an unpublished description of the astrolabe by Professor E. Birnbaum, Department of Middle East & Islamic Studies, University of Toronto, which the Ontario Science Centre has kindly sent me on 2 March 1993.

COMPONENTS

Body with *kursī* (d. 146, t. 9), shackle and ring, rete, 5 plates, alidade, pin, washer and horse.

FRONT

The ring has circular cross-section; its two ends are not joined together. The shackle has trifoliate form; this shape is not repeated in its two bases which are roundish. The *kursī* is lobed with a trifoliate finial; is finely worked *à jour,* with a triangular piece at the centre and surface decorations on both sides. The limb divided in 0;30°, 1° and 5° and numbered 5—360.

Figure A037.2 – Rete of the Astrolabe (photo courtesy Ontario Science Centre)

RETE

The two rings of the Tropic of Capricorn and the ecliptic are held together by the equinoctial bar which has a counter change at the centre. About 49 star pointers, 28 inside the ecliptic circle and 21 outside, are joined by an almost symmetric floriated tracery. The ecliptic circle is divided into 12 zodiac signs and labelled with their names, each sign is divided into groups of 6° and numbered accordingly, and each of the units are divided into two halves to represent 3°. There are about 40 star pointers, but it was not possible to decipher the names in the available photos, especially those inside the ecliptic circle. Most of the stars outside the ecliptic are enumerated below.

Table A037-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus Janūbī*	β Ceti
2	*Fam al-Qayṭus*	γ Ceti
3	*Ṣadr al-Qayṭus*	π Ceti
4	*ᶜAyn al-Thawr*	α Tauri
5	*ᶜAyyūq*	α Aurigae
6	*Rijl al-Jawjā' al-Yusrā*	β Orionis
7	*Yad al-Jawjā' al-Yusrā*	γ Orionis
8	*Yad al-Jawjā' al-Yumnā*	α Orionis
9	*Rijl al-Jawjā' al-Yumnā*	κ Orionis
10	*Shiᶜrā Yamānī*	α Canis Majoris
11	*Shiᶜrā Shāmī*	α Canis Minoris
12	?	
13	*Fard al-Shujāᶜ*	α Hydrae
14	*Qāᶜidāt al-Bāṭiya*	α Crateris
15	*Janāḥ al-Ghurāb*	γ Corvi
16	*Simāk al-Aᶜzal*	α Virginis
17	*Qalb al-ᶜAqrab*	α Scorpii
19	*Nasr Wāqiᶜ ?*	α Lyrae
20	*Nasr al-Tāir*	α Aquilae
21	*Dhanab al-Jadī*	δ Capricorni

PLATES

There are five plates in the astrolabe. Of the 10 photos, it is not possible to determine which two plate faces belong to the same plate. Therefore, these are numbered below serially from 1 to 10. None seem to carry labels about the latitude for

which the plate is calibrated and the duration of the longest day at that latitude. Plate face 1 is engraved with multiple horizons and seems to be genuine. All the others appear to be spurious: latitude 30° is repeated in two, lat. 60° is repeated in two other plate faces. On all plate faces from 2 to 9, altitude circles are drawn for every 6° and numbered; azimuths are traced below the horizon and numbered; lines for seasonal hours are marked and numbered.

1. Tablet of horizons, appears to be genuine.
2. Blank.
3. Made for the latitude of 30°.
4. Also made for 30°.
5. Calibrated for the latitude of 60° which is most unusual.
6. Also calibrated for 60°.
7. Latitude 24°.
8. Latitude 27°.
9. Latitude 21°. The notch is at the west point and not at the north point as in others.
10. Latitude 36°? Altitude circles for 3°, not drawn uniformly, nor numbered. There are no azimuths; there are lines for seasonal hours, but not numbered.

Figure A037.3 – Geographical Gazetteer (photo courtesy of Ontario Science Centre)

Geographical Gazetteer

On the inner surface of the mater is engraved a geographical gazetteer of 85 localities with their longitudes and latitudes in four concentric circles which are separated from one another by an empty band.

Table A037-2 Geographical Gazetteer

	Place Name *asmā al-buldān*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
	First Circle		
1	Qayrawān	41;0	31;40
2	Miṣr	63;20	30;20
3	ᶜAdan	76;0	11;0

	Place Name *asmā al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*
4	Madīnat al-Rasūl	75;20	25;0
5	Makka Muᶜaẓẓam	77;10	21;40
6	Hajar Baḥrayn	83;0	25;15
7	Bayt al-Maqdis	66;30	31;50
8	Dimashq	70;0	33;15
9	Ḥalab	72;0	35;50
10	Iṣṭanbul	59;50	45;0
11	Raqqa	73;45	36;1
12	Mawṣil	77;0	34;30
13	Nakhjavān	81;55	38;40
14	Marāgha	82;0	37;20
15	Tabrīz	82;0	38;0
16	Bardaᶜa	83;0	40;30
17	Pākūya	84;30	39;30
18	Bāb al-Abwāb	85;0	43;0
19	Bulghār	90;0	49;30
20	Kūfa	79;30	31;30
21	Baghdād	80;0	38;25
22	Baṣrah	84;0	30;11
23	Rām Hurmūz	85;45	31;0
24	Fīrūzābād	87;30	28;10
25	Yazd	89;0	32;0
26	Shīrāz	88;0	29;36
27	Hamadān	88;0	25;10

	Place Name *asmā al-buldān*	L *al-ṭūl*	φ *al-ʿarḍ*
28	Qazwīn	85;0	36;0
29	Iṣfahān	86;40	32;25
30	Kāshān	86;0	34;0
31	Qumm	85;40	34;45
32	Rayy	86;20	35;0
33	Ṭālīqān	85;45	36;10
34	Astarābād	89;35	36;50
35	Samnān	88;0	36;0
36	Bisṭām	89;30	36;31
37	Sabzawār	91;30	36;5
38	Harāt	94;20	34;30
39	Marw	87;0 (sic!)	37;40
	Second Circle		
40	Balkh	101;0	36;41
41	Qabādhiyān	102;0	37;45
42	Badakhshān	104;24	37;10
43	Andarāb	103;45	36;0
44	Bukhārā	107;30	39;50
45	Samarqand	109;36	39;37
46	Hazār Āsf	105;0	41;0
47	Khujand	100;36	41;50
48	Kāshghar	106;30	44;0
49	Khutan	107;0	42;0
50	Qarāqūrūm	115;0	46;0

	Place Name *asmā al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*
51	Hurmūz	102;0	26;50
52	Ghazna	104;20	33;35
53	Kābul	104;40	34;30
54	Ribāṭ Amīr	105;0	34;0
55	Peshāwar	107;10	33;25
56	Dabīl	102;30	25;10
57	Bakr	105;0	27;40
58	Somnāt	106;0	17;0
59	Qandahār	107;40	33;0
60	Awadh	106;20	28;40
61	Mūltān	107;35	29;40
62	Lahāwar	109;20	31;50
63	Siālkot	109;4	38;0
64	Tubbat	110;0	40;0
65	Kashmīr	108;0	35;0
66	Sarāndīb	130;0	10;0
	Third Circle		
67	Qannawj	115;50	26;35
68	Banarasi	117;20	26;55
69	Haḍrat Dihlī	113;35	28;55
70	Tānīsar	112;13	30;10
71	Sambhal	105;0	28;4
72	Akra	114;0	27;13
73	Kawāliyār	115;0	26;29

	Place Name *asmā al-buldān*	L *al-ṭūl*	φ *al-ʿarḍ*
74	Jawnpūr	109;6	26;37
75	Mānakpūr	108;10	26;49
76	Barūj	111;5	21;20
77	Dhārmā Qaṣba Lū?	110;15	24;0
78	Ajmīr	112;24	26;0
79	Ujjayn	102;0	22;30
80	Aḥmadābād	108;40	23;15
81	Burhānpūr	103;0	21;30
	Fourth Circle		
82	Dawlatābād	111;0	20;30
83	Lankā[312]	110;50	0;0
84	Khanbhāyat	109;20	24;30
85	Bījāpūr	105;30	17;20

BACK

On the back, the rim of the upper half carries the altitude scales, divided in 0;30°, 1°, 5° and numbered 5—90; 90—5.

In the upper left quadrant are drawn 60 horizontal parallels with each fifth line highlighted with dots. The upper right quadrant bears 30 declination arcs, one for each 6° of solar longitude. Along the two radii are engraved the names of the corresponding signs and the degrees of their parts (as 6, 12, …30). Upon these quarter circles are

312 Lankā at 0;0 lat, 110;50 long, reflects the notional point of Sanskrit astronomy of zero meridian and zero longitude. This place name does not occur in any other astrolabe. It is different from the actual Sri Lanka, listed under no. 66 as *Sarāndīb.*

plotted two sigmoid graphs of the solar meridian altitude for the latitudes of 27° and 32° (representing the two imperial cities Agra and Lahore) with the usual legends.

In the lower half are two shadow squares; on the left for a base of 12, on the right for a base of 7. The vertical and horizontal scales on the left and on the right are divided and numbered accordingly. These scales bear the following labels:

Vertical scale on the left: *ẓill sullam aṣābi*^{c} *ma*^{c}*kūs*
Horizontal scale on the left: *ẓill sullam aṣābi*^{c} *mustawī*
Horizontal scale on the right: *ẓill sullam aqdām mustawī*
Vertical scale on the right: *ẓill sullam aqdām ma*^{c}*kūs*

Two rectangular tables are engraved inside these shadow squares. The one on the left carries the heading *faḍl al-dawr* (excess of revolution) and shows the multiples of the difference between the length of the tropical year and 365 Days. The table on the right is entitled *arbāb muthallathāt laylī wa yawmī* (the regents of the triplicitities at night and in the day) and shows the signs and the regents (represented by the last consonant of their names in Arabic) without, however, classifying them according to the four elements, as is done on some astrolabes described before.

Below the shadow squares are several concentric semi-circular rows; their configuration is somewhat unusual. The outermost rim, corresponding to the altitude scale in the upper half is blank. The cotangent scales which are usually inscribed here is placed further inside. The semi-circles following the blank rim successively display the following data.

Row 1. The quarter circle on the left is divided into unequal divisions and numbered from the horizontal diameter to the vertical, serially from 1 to 23 and 24 (?); the purpose of this scale is not clear. The quarter circle on the right is divided into 18 equal divisions of 5° each and numbered in 5s from 5 to 90.

Row 2. Blank.

Rows 3-4. In row 4 are marked the cotangent scales, labelled on the left *al-aṣābi*^{c} (digits) and on the right *al-aqdām* (feet). On both sides there are unequal divisions which are numbered in 5s from 5 to 60. On row 3, fractions of the divisions in row 3 are marked; but this done only on the right; the quarter circle on the left is blank.

Row 5. Blank.

Rows 6-7. Names of the 28 lunar mansions and the names of the 12 corresponding zodiac signs.

Rows 7, 8, 9. Table of the limits.

Rows 7, 10, 11. Table of faces.

Figure A037.4 – Back of the astrolabe (photo courtesy Ontario Science Centre)

ALIDADE ETC.

Straight bar alidade with a simple centre piece, but with ornate ends. The photo shows the back of the alidade; it is not known whether the front is calibrated. Simple pin. In the wedge, the horse's head is moulded nicely showing the ears, eyes and mouth.

INSCRIPTION

In two lines, between the shadow squares and the semi-circular tables, written upside down.

> *aḍᶜaf al-ᶜibād muḥammad muqīm ibn mullā ᶜīsā*
> *ibn shaykh allāhdād asṭurlābī humāyūnī lāhūrī*
> '[The work of] the weakest of the servants [of God], Muḥammad Muqīm, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.'

PROVENANCE

The Ontario Science Centre informed me in November 2012 that the astrolabe has been missing since 2000.

A038 ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED

Diameter 140 mm

PLU, ex. Sotheby's

CCA 2609 Répertoire 26

COMPONENTS

Body with *kursī* (d. 140), shackle and ring, rete for 37? stars, 5 plates, alidade, pin and horse.

BACK

Trigonometric quadrant; solar quadrant with curves of the midday altitude of the sun at latitudes 27° and 32°; shadow squares and astrological tables.

INSCRIPTION

ᶜamal muḥammad muqīm ibn ᶜīsā ibn allāhdād asṭurlābī humāyūnī lāhūrī

'The work of Muḥammad Muqīm, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.'

BIBLIOGRAPHY

Sotheby's catalogue of 26 February 1968, lot 14.

A039$^{\odot}$ ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED

Diameter 134 mm

New Haven, Yale University, Harvey Cushing/John Hay Whitney Medical Library, Edward Clark Streeter Collection of Weights & Measures

CCA 3807; Répertoire 30

Figure A039.1 – Geographical Gazetteer
(photo courtesy of Harvey Cushing/John Hay Whitney Medical Library)

COMPONENTS

Only the mater with *kursī* (d. 134, h. 161, t. 5) is extant. The limb is made separately and joined to the back plate by means of five rivets.

FRONT

The *kursī* has lobed profiles. The trifoliate finial which is a common feature in Muqīm's astrolabes is missing here; instead, there is a circular hole at the apex of the *kursī*. Whether this hole was originally intended for the shackle or whether the finial is broken is not certain. The *kursī* is elegantly pierced with decorative engravings on the surface. The limb is divided in 1° and 6° and numbered 6—360.

GEOGRAPHICAL GAZETTEER

On the inner side of the mater, there is a small peg at the north point to hold the plates in position. The surface carries a geographical gazetteer inscribed in three concentric circles, which are separated from one another by double lines. The gazetteer contains the names, longitudes and latitudes of 69 localities. In the outer circle, the data is engraved upside-down, but it is straight in the other two circles.

Table A039-1 Geographical Gazetteer

	Place Name *al-bilād*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
	Outer Circle		
1	Miṣr	63;20	30;20
2	ᶜAdan	76;0	11;0
3	Madīnat Ṭayyaba	75;20	25;0
4	Makka Muᶜaẓẓam	77;10	21;40
5	Bayt al-Maqdis	66;30	31;50
6	Dimashq	70;0	33;15
7	Ḥalab	72;10	35;50
8	Marāgha	82;0	37;20
9	Tabrīz	82;0	38;0

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
10	Kūfa	79;30	31;30
11	Baghdād	80.0	33;25
12	Baṣrah	84;0	30;0
13	Fīrūzābād	87;30	28;10
14	Shīrāz	88;0	29;36
15	Yazd	89;0	32;40
16	Qazwīn	85;0	36;0
17	Iṣfahān	86;40	32;35
18	Kāshān	86;0	34;0
19	Qum	85;40	34;45
20	Rayy	86;20	35;0
21	Astarābād	89;35	36;50
22	Bisṭām	89;30	36;10
23	Sabzawār	91;30	36;5
24	Mashhad	92;30	36;0
25	Harāt	94;20	34;30
26	Balkh	101;0	36;41
27	Badakhshān	104;24	37;10
28	Bukhārā	97;30	39;50
29	Samarqand	99;36	39;37
30	Khujand	100;35	41;55
31	Kāshghar	106;30	44;0
	Middle Circle		
32	Khutan	107;0	42;0

	Place Name ***al-bilād***	**L** ***al-ṭūl***	**φ** ***al-ʿarḍ***
33	Hurmūz	92;0	25;0
34	Kirmān	91;30	30;0
35	Ghazna	104;20	33;35
36	Kābul	104;40	34;30
37	Daybul	102;30	25;10
38	Qandahār	107;40	33;0
39	Tubbat	110;0	40;0
40	Kashmīr	108;0	35;0
41	Parshūr	105;15	31;0
42	Mūltān	107;35	29;40
43	Sālkot	109;0	33;0
44	Lāhūr	109;20	31;50
45	Tānīsar	112;33	30;10
46	Pānīpahtah	113;20	28;52
47	Hadhrat Dihlī	113;35	28;39
48	Akra	115;0	26;43
49	Qanūj	115;50	26;35
50	Kawālīyar	114;0	26;29
51	Banāras	117;20	26;55
52	Lakhnawtī	114;13	26;30
53	Kopāmāyū	116;33	26;45
54	Jawnpūr	119;6	26;36
	Inner Circle		
55	Kara	118;10	29;49

	Place Name *al-bilād*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
56	Jadda	77;0	21;0
57	Ujjayn	102;0	22;30
58	Ajmīr	111;5	26;0
59	Baran	114;0	28;48
60	Kol	114;19	28;4
61	Badāūn	114;19	27;12
62	Sarūj	72;40	34;50
63	Nawshahar	78;20	38;10
64	Jamkūt	177;0	5;0
65	Farmal	104;35	32;55
66	Burhānpūr	103;0	20;30
67	Dawlatābād	101;0	20;30
68	Bījāpūr	105;30	16;20
69	Kanbāyat	109;20	26;20

BACK

The rim of the upper quadrant carries the altitude scales divided in 1° and in 6° and labelled 6—90; 90—6. The rim of the lower half carries the cotangent scales, on the left *al-aṣābiᶜ* (digits) and on the right *al-aqdām* (feet).

Figure A039.2 – Back of the astrolabe (photo courtesy Harvey Cushing/John Hay Whitney Medical Library

The upper left quadrant is engraved with 30 horizontal parallels, where every third line is highlighted with dots.

The upper right quadrant carries six declination arcs, one for each pair of zodiac signs which are marked with their serial numbers on the two radii. Two graphs of the solar meridian altitude for the latitudes 27° and 32° are plotted with the usual labels.

In the lower half there are shadow squares, on the left for the base of 12 and on the right for the base of 7, with the usual divisions and labels.

Inside the shadow squares are two concentric semi-circles carrying the names of the 12 zodiac signs and those of the 28 lunar mansions.

Inscription

Inside the two semi-circles is the maker's signature in three lines written upside-down:

*sana*ᶜ*at muḥammad muqīm ibn* ᶜ*īsā*

ibn allāhdād asṭurlābī humāyūnī

lāhūrī

‘Made by Muḥammad Muqīm, son of ᶜĪsā, son of Allāhdād of Lahore, astrolabe maker to [the Emperor] Humāyūn.’

A040☉ ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED

Diameter 129 mm

Oxford, Museum of the History of Science (#37530)

CCA 1013; Répertoire 20

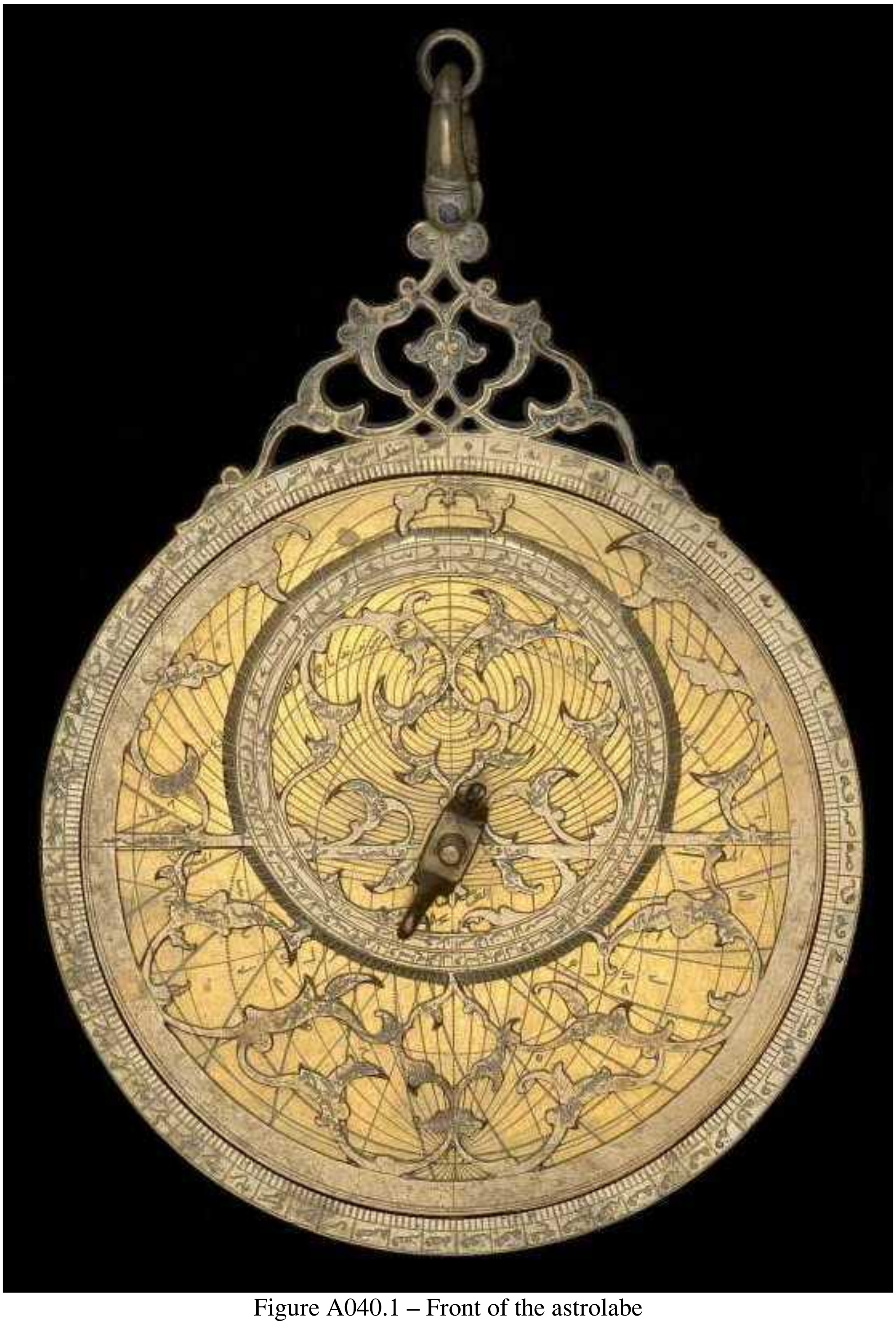

Figure A040.1 – Front of the astrolabe
(© Museum for the History of Science, Oxford)

It is an elegantly crafted astrolabe with some innovations not found elsewhere. In the solar quadrant on the back, besides the sigmoid graph for the midday altitude of the sun at latitude 27°, there are two other graphs to show the beginning and end of the mid-afternoon prayer *al-casr* throught the year. Second, on the latitude plate 2, which is calibrated for 27° (Agra) on one side and for 32° (Lahore) on the other, there are crepuscular prayer lines below the eastern and western horizons. There are also *ghaṭī* lines on these two sides. Third, on the plate 4b containing a triple projection for the latitudes 0° + 72° + 90°, there are declination scales.

COMPONENTS

Body with *kursī* (d. 129, h. 166, t. 8), shackle and ring, rete (d. 117) for 41 stars, 5 plates (d. 117). Alidade, pin and horse are missing. The ensemble is held together by a modern bolt and nut.

FRONT

The ring is very small; the two ends are welded together. The shackle has trifoliate shape and diamond cross-section. The *kursī* has an interesting profile with lobes and sharp projections, topped by a trifoliate finial. It is pierced with just 8 perforations but has a pleasing design with a diamond-shaped motif in the middle, which repeats itself twice in the rete below. Decorative engravings on the surface on both sides.

The limb is divided in 1° and 5° and labelled 5—360.

RETE

The broad Capricorn ring and the equally broad ecliptic ring are joined by the equinoctial bar with counter changes. The inner edge of the Capricorn constitutes the Tropic of Capricorn and not the outer circle as is the usual case. Consequently, the first point of Capricorn in the ecliptic ring is far removed from the degree scale on the limb. This gap is bridged by an ornate arch set upon the ecliptic ring and this arch functions as the Capricorn index (*al-muri*).

The ecliptic circle is divided into 12 signs and labelled with their names. Each sign is divided into five units which are numbered as 6, 12, 18, 24, 30. Divisions of 3° are marked on the sloping edge of the ecliptic ring. Originally there was a handle in a part of the tracery inside the ecliptic ring which is now lost; only the hole remains.

There are a very large number of stars on this small astrolabe. Their names are engraved in miniscule letters but still very clearly written.

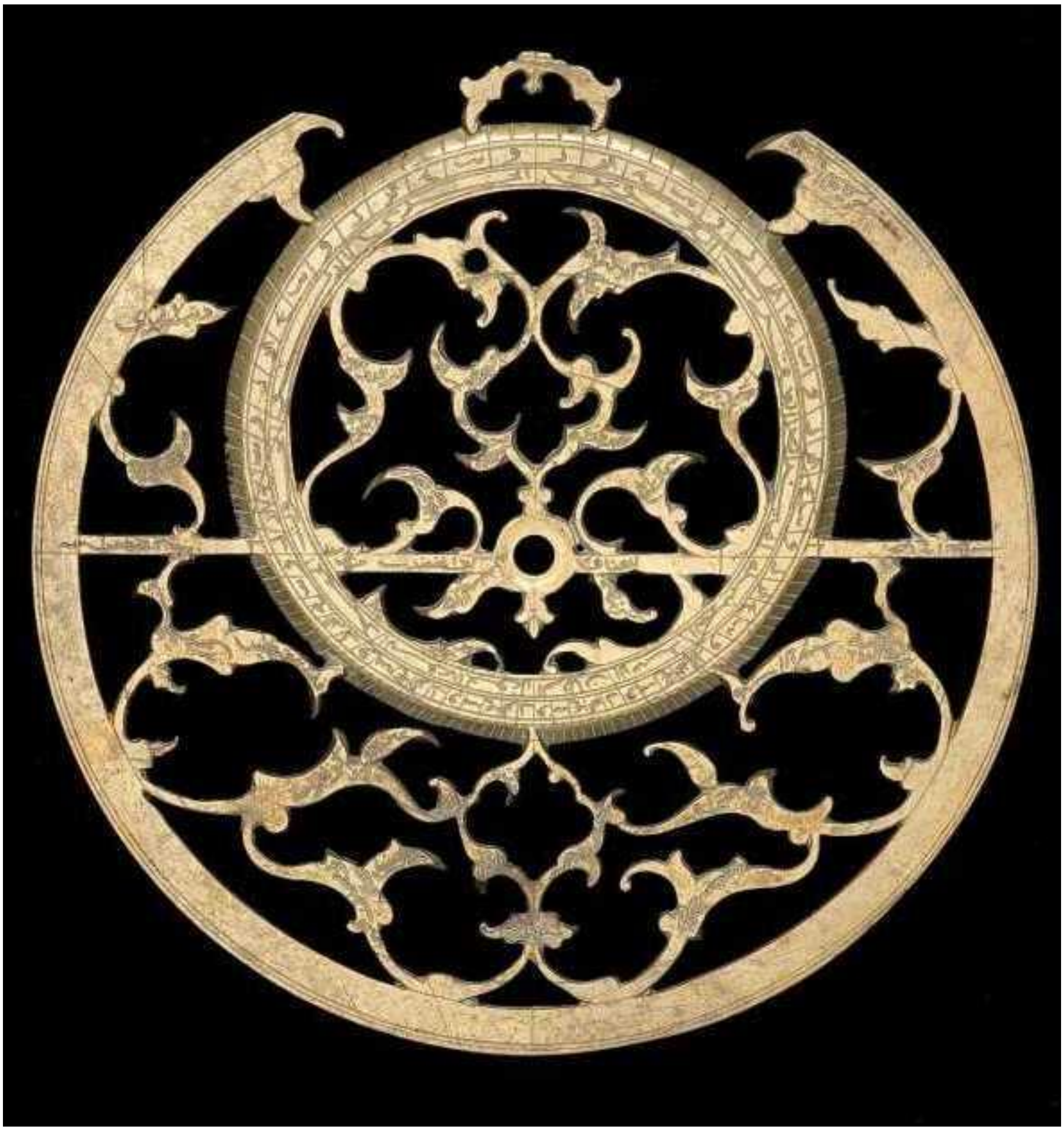

Figure A040.2 – Rete of the Astrolabe (© Museum of the History of Science, Oxford)

Table A040-1 Stars on the Rete

	Star Name	Identification
01	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
02	*Baṭn [al-Ḥūt]*	β Andromedae
03	*Rijl al-Musalsala*	γ Andromedae
04	*Fam al-Qayṭus*	γ Ceti
05	*Kaff al-Jadhmā'*	α Ceti

	Star Name	Identification
06	*[Rās al-] Ghūl*	β Persei
07	*Tālī Masāfat al-Nahr*	γ Eridani
08	*ᶜAyn al-Thawr*	α Tauri
09	*ᶜAyyūq*	α Aurigae
10	*Rijl Yusrā*	β Orionis
11	*Yad Yusrā*	γ Orionis
12	*Rijl Jawjā' [Yumnā]*	κ Orionis
13	*Yad Yumnā*	α Orionis
14	*Shiᶜrā Yamānī*	α Canis Majoris
15	*Shiᶜrā Shāmī*	α Canis Minoris
16	*Ṭarfat al-Safīna*	ρ Puppis
17	*Fard al-Shujāᶜ*	α Hydrae
18	*Qalb al-Asad*	α Leonis
19	*Ẓahr Dubb Akbar*	α Ursae Majoris
20	*Qāᶜidat al-Bāṭiya*	α Crateris
21	*Al-ᶜAnāq*	ξ Ursae Majoris
22	*Janāḥ al-Ghurāb*	γ Corvi
23	*Simāk al-Aᶜzal*	α Virginis
24	*Simāk Rāmiᶜ*	α Bootis
25	*Nayyir Fakka*	α Coronae Borealis
26	*ᶜUnuq al-Ḥayya*	α Serpentis
27	*Qalb al-ᶜAqrab*	α Scorpii
28	*Rās al-Ḥawwā'*	α Ophiuchi
29	*Yad al-Ḥawwā' al-Yamīnī al-Muqaddam*	δ Ophiuchi

	Star Name	Identification
30	?	
31	*Nasr Wāqi*[c]	α Lyrae
32	*Minqār Dajāja*	β Cygni
33	*Dhanab al-Dūlfīn*	ε Delphini
34	*Dhanab Dajāja*	α Cygni
35	*Fam al-Faras*	ε Pegasi
36	*Dhanab al-Jadī*	δ Capricorni
37	*Mankib Sākib al-Mā'*	α Aquarii
38	*Sāq Sākib al Mā' J[anūbī]*	δ Aquarii
39	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
40	*Surrat Faras*	δ Pegasi
41	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are five plates with the following specifications.

Table A040-2 Plates

	φ	Longest Day
1a	22°	13;22 hours
1b	25°	13;25 hours
2a	27°	13;43 hours
2b	32°	14;8 hours
3a	36°	14;32 hours
3b	18° + 30°	

	φ	Longest Day
4a	40°	14;54 hours
4b	0° + 72° + 90°	
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

In all plates (except 5b) altitude circles are traced for every 3° and every fifth of these (15°) is highlighted by dots; the circles are numbered on both sides. Azimuth arcs drawn below the horizon for every 10°. The prime meridian is dotted. Lines are drawn for seasonal hours and for equal hours from the western horizon. The east and west points labelled.

On the two sides of plate 2 serving the latitudes 27° and 32°, dotted lines are drawn for equal *ghaṭīs* from the western horizon. There are also crepuscular prayer lines below the eastern and western horizons.

On 3b which has the double projection for 30° and 18° altitude circles are drawn for3° and labelled; plain lines for seasonal hours and dotted lines for equal hours counted from both eastern and western horizons, but no azimuth arcs.

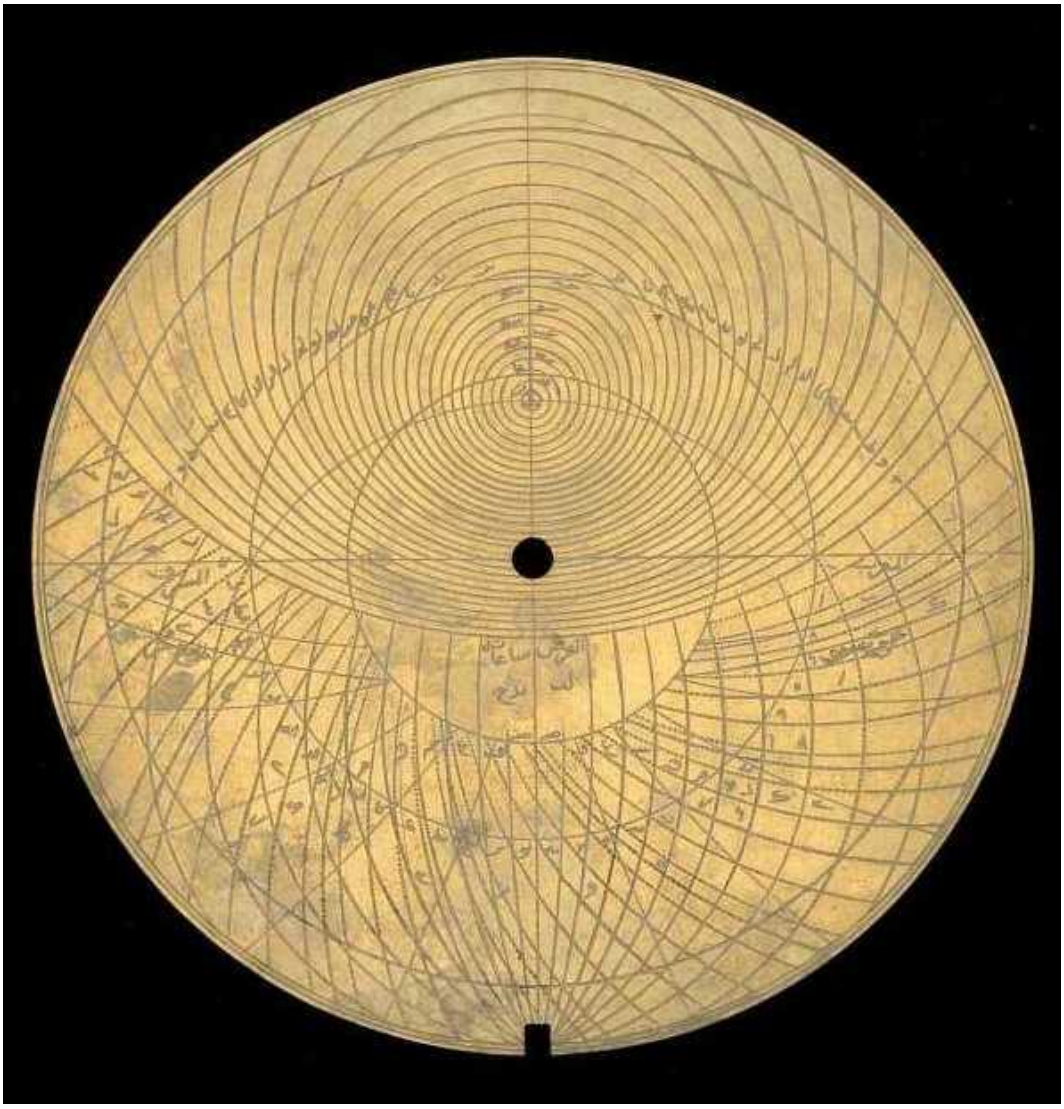

Figure A040.3 – Plate for the latitude of Lahore at 32°
(© Museum of the History of Science, Oxford)

4b. The triple projection of 0°, 72° and 90° is as in the astrolabe of 1643 (A030), but an innovation is made here by introducing declination scales between the Capricorn circle and equatorial circle at the eastern and western horizons, and at the lower meridian that separates the projections for 90° and 72°.

5a. In the tablet of ecliptic coordinates, circles of latitudes are drawn for each 3° and circles of latitudes for each 10° and numbered. The names of the signs are written along the ecliptic circle, but there is no label for the plate itself.

5b. In the tablet of horizons, half horizons are drawn for latitudes with even number of degrees from 6° to 68°; in four sets, with intervals of 8° in each set.

6	14	22	…	62
8	16	24	…	64

10	18	26	…	66
12	20	28	…	68

There are declination scales divided in 2° and labelled 6, 12, 18, 23;30. There is no label for the plate.

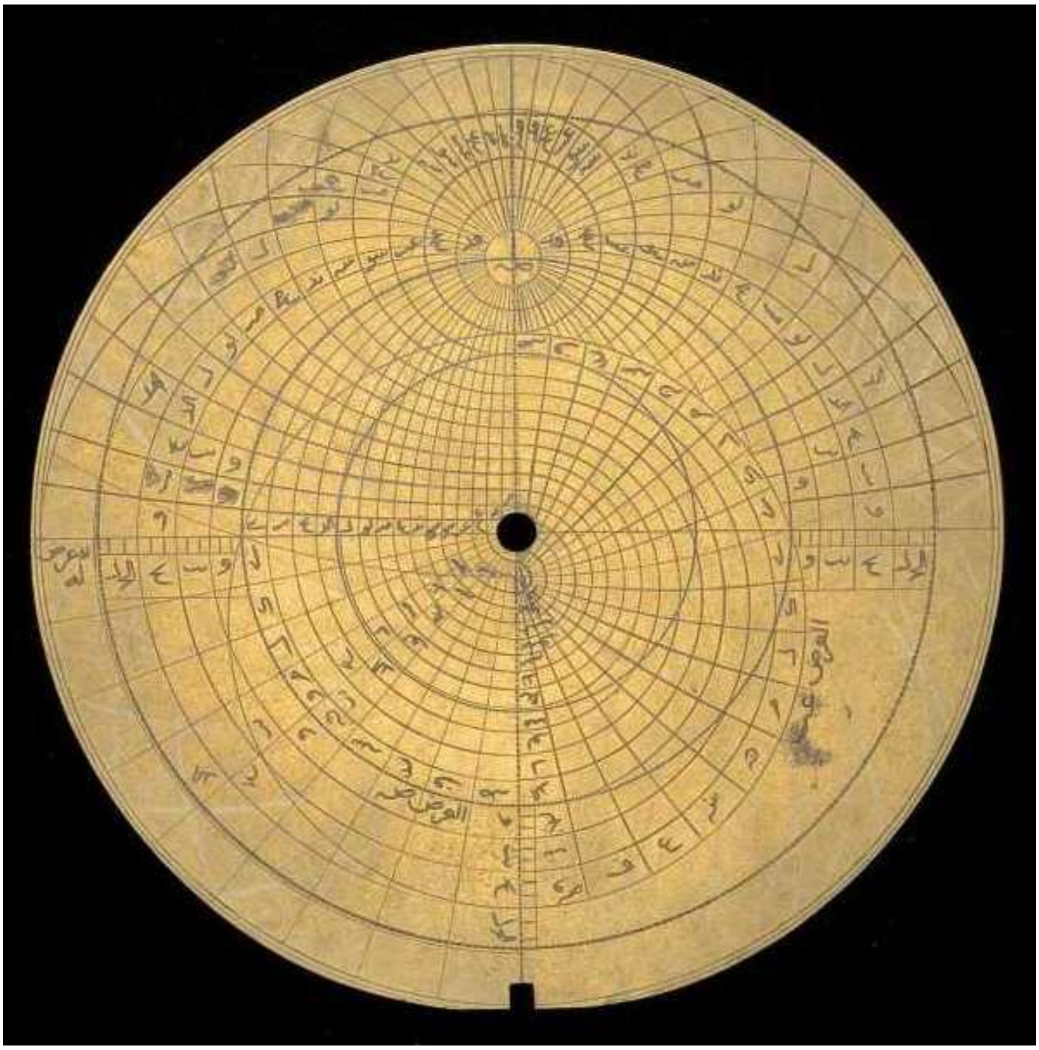

Figure A040.4 – Projections for the latitudes 0°, 72° and 90°
(© Museum of the History of Science, Oxford)

A rectangular peg is affixed at the north point inside the limb in order hold the plates in position. Accordingly, the plates have notches at the north point. However, plate 3 has two notches at the north point and at 90° from it. If the two projections for 18° and 30° on 3b were to be made use of, there ought to be notches at north and south points. In the tablet of horizons there is only one notch at the north point, although it needs notches at all the four points of compass so that the four sets of half-horizons can be made use of.

Figure A040.5 – Geographical gazetteer
(© Museum of the History of Science, Oxford)

GEOGRAPHICAL GAZETTEER

The gazetteer is inscribed in three circles with the names, longitudes and latitudes of 77 localities. The letters are written upside-down, i.e., the tops of the letters are towards the centre of the astrolabe. The enumeration begins at the top of the inner circle and proceeds from right to left, roughly according to increasing longitude.

Table A040-3 Geographical Gazetteer

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ʿarḍ*
	Inner Circle		

	Place Name *al-bilād*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
01	Miṣr	63;20	30;20
02	ᶜAdan	76;0	11;0
03	Madinat Rasūl ᶜAlayhi al-Salām 75;20	25;0	
04	Makka Muᶜaẓẓam	77;10	21;40
05	Tā’īf	77;30	21;20
06	Bayt al-Maqdis	66;30	31;50
07	Dimashq	70;0	33;15
08	Ḥalab	72;10	35;50
09	Qūnya	66;30	41;0
10	Raqqa	73;15	36;0
11	ᶜĀna	76;30	34;0
12	Mawṣil	77;0	34;30
13	Nakhajwān	81;15	38;40
14	Tabrīz	82;0	38;0
15	Bardaᶜa	83;0	40;30
	Middle Circle		
16	Bāb al-Abwāb	85;0	43;0
17	Bulghār	90;0	49;30
18	Kūfa	79;30	31;30
19	Madā’īn	72;0	33;10
20	Baghdād	80;0	33;25
21	Baṣra	84;0	30;0
22	Arjān	86;30	35;30

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ʿarḍ*
23	Fīrūzābād	87;30	28;10
24	Shīrāz	88;0	29;36
25	Yazd	89;0	32;40
26	Abhar	84;30	36;45
27	Hamadān	83;0	35;10
28	Karaj	84;45	32;0
29	Sāwa	85;0	35;0
30	Qazwīn	85;0	36;0
31	Iṣfahān	86;40	32;25
32	Kāshān	86;0	34;0
33	Qum	85;40	34;45
34	Rayy	86;20	35;0
35	Khuwār	87;10	35;40
36	Ṭāliqān	85;45	36;10
37	Astarābād	89;35	36;50
38	Jarjān	90;0	36;50
	Outer Circle		
39	Busṭām	89;30	36;10
40	Sabzawār	91;30	36;5
41	Nīshābūr	92;30	36;21
42	Ṭūs	92;30	37;0
43	Tūn	92;30	34;30
44	Harāt	94;20	34;30
45	Marw	97;0	37;40

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
46	Balkh	100;0 !	36;41
47	Badakhshān	104;24	37;10
48	Bukhārā	97;30	39;50
49	Samarqand	99;16	39;37
50	Khujand	100;35	41;55
51	Kāshghar	106;30	44;0
52	Khutan	107;0	42;0
53	Hurmūz	92;0	35;0
54	Maymand	104;40	35;0
55	Dabīl	102;30	25;2
56	Mūltān	107;35	29;40
57	Qandahār	107;40	33;0
58	Kābul	104;40	35;0
59	Kashmīr	108;0	35;0
60	Tubbat	110;0	40;0
61	Lahāwar	109;20	31;50
62	Tānīsar	112;25	30;10
63	Dihlī Haḍrat	113;35	28;0 !
64	Akra	115;0	26;46
65	Qannawj	115;50	106;35 !
66	Bānārasī	117;20	26;55
67	Sarāndīb	130;0	10;0
68	Kawāliyār	115;0	26;29
69	Ajmīr	112;5	26;0

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
70	Ujjayn	112;0	22;30
71	Badāwan	119;29	27;42
72	Sanbhal	115;0	28;18
73	Aḥmadābād	108;40	23;15
74	Bījāpūr	108;30	17;20
75	Mandū	111;25	22;15
76	Jadda	76;0	21;0
77	Kanbāyat	109;20	22;20

BACK

The rim of the upper two quadrants carries altitude scales which are divided in 1° and 5° and labelled 5—90; 90—5. In the upper left quadrant are drawn 60 horizontal parallels, with every fifth dotted. In the upper right quadrant, declination circles are traced for every 10° of solar longitude. Along the vertical radius the signs from the summer solstice to the winter solstice, i.e., from *al-Saraṭān* (Cancer) to *al-Qaws* (Sagittarius) with their divisions are written from the centre to the periphery. Along the horizontal radius the signs from the winter solstice to the summer solstice, i.e., *al-Jadī* (Capricorn) to *al-Jawzā'* (Gemini) with their divisions are written from the periphery up to the centre.

Superimposed on these are three graphs; the upper one represents the solar meridian altitude throughout the year at the latitude of 27° and carries the label *khaṭṭ niṣf al-nahār al-ᶜarḍ 27.* The other two lines are the graphs of the beginning and end of the mid-afternoon prayer *al- ᶜaṣr,* with the labels *awwal ᶜaṣr* and *ākhir ᶜaṣr* .

In the lower half, there are shadow squares, on the left for the base of 12 and on the right for the base of 7. The vertical and horizontal scales on the left and right divided and numbered accordingly. These scales carry the following labels:

Vertical scale on the left: *ẓill sullam aṣābiᶜ maᶜkūs*

Horizontal scale on the left: *ẓill sullam aṣābi^c mustawī*

Horizontal scale on the right: *ẓill sullam aqdām mustawī*

Vertical scale on the right: *ẓill sullam aqadām ma^ckūs*

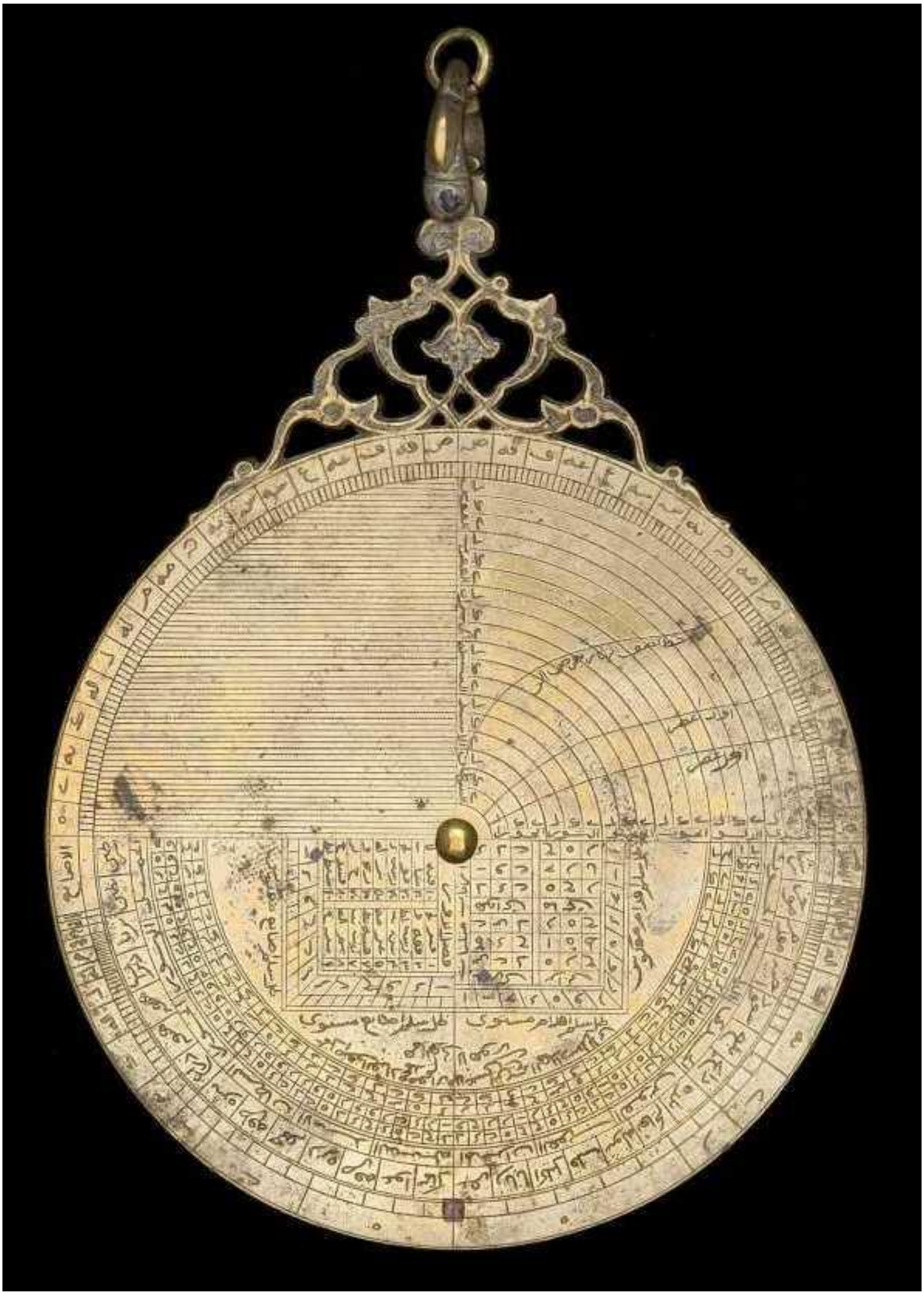

Figure A040.6 – Back of the astrolabe
(© Museum of the History of Science, Oxford)

Inside these shadow squares are engraved two rectangular tables. The table on the left is entitled *faḍl al-dawr* (excess of revolution) and contains multiples of the difference between the true and nominal years. The table on the right bears the heading *arbāb al-muthallathāt* (regents of the triplicities) and arranges the signs and their diurnal and nocturnal regents according to the four elements *nārī* (fiery), *tatāmi* (earthy), *hawā'ī* (airy) and *mā'ī* (watery).

Table A040-4 Triplicities and their Regents

nārī (fiery)				*tarābī* (earthy)		
Sun	Jupiter	Saturn		Venus	Moon	Mars
Aries	Leo	Sagittarius		Taurus	Virgo	Capricorn
Jupiter	Sun	Saturn		Moon	Venus	Mars
hawā'ī (airy)				*mā'ī* (watery)		
Saturn	Mercury	Jupiter		Venus	Mars	Moon
Gemini	Libra	Aquarius		Cancer	Scorpio	Pisces
Mercury	Saturn	Jupiter		Mars	Venus	Mon

The rim of the lower half bears the two cotangent scales, on the left in digits (*al-aṣābi*^{c}) and on the right in feet (*al-aqdām*). The divisions in these scales are subdivided into 5 parts each in the immediately following semi-circular row. This is followed by 6 semi-circular rows. The first two rows contain the names of the 28 lunar mansions and the names of the 12 corresponding zodiac signs The next two rows form the table of limits (*ḥudūd*) and the last two the decans (*wujūh*) and their regents.

INSCRIPTION

Beneath the shadow squares, along the curve of the semi-circular table is inscribed the signature of the maker, but no date:

> ^{c}*amal aḍ*^{c}*af al-*^{c}*ibād muḥammad muqīm ibn mullā* ^{c}*īsā ibn shaykh allāhdād [a]sṭurlābī humāyūnī lāhūrī.*
>
> 'The work of the weakest of the servants [of God], Muḥammad Muqīm, son of Mullā ^{c}Īsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.'

PROVENANCE

Formerly in the Henri Michel Collection, Brussels.

J. A. Billmeir Collection

BIBLIOGRAPHY

Michel 1947, Plate XXI: front and back, Fig. 22: gazetteer. The caption under the gazetteer states ‘Table of Qibla azimuths’, but these are only longitudes and latitudes.

A041⊙ ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED

Diameter 107 mm

PLU, ex-Antwerp, PC

Figure A041.1 – Front of the astrolabe (photo by S. R. Sarma)

In this astrolabe, on both sides of the five plates (including the tablet of ecliptic coordinates and the tablet of horizons), there are two concentric circles on the rim. In the inner circle are engraved the names of 16 places whose latitudes are close to the

latitude for which the plate is calibrated. In the outer rim are given the longitudes and latitudes of these 16 places in 32 cells. There is only one more specimen among the Lahore astrolabes which exhibits this feature, but only partially (A014). I regret very much that when I examined this astrolabe briefly in 1996, I did not appreciate the importance of this feature and did not photograph all the plates. I have photocopies of two pages where the obverse and reverse sides of all the components of the astrolabe are illustrated. The pages are apparently from an unidentified catalogue of Christie's with the serial numbers K 39564 and K39565. I tried to enlarge the images of the individual plates and to copy the gazetteers on the rim, but these images were trimmed around, cutting off the lower part of the *abjad* numerals denoting the longitudes and latitudes.

Since the rims of the plates are covered by this gazetteer, the circle of the Tropic of Capricorn lies several mm inside on the plates as well as on the rete. Consequently, the upper part of the ecliptic ring is far away from the degree scale on the rim. In order to bridge this gap, a trifoliate arch is attached to the topmost point of the ecliptic ring to function as the Capricorn index (*al-mūri*), as is done in A014 and also in A038.

Components

Body with *kursī* (d. 107, h. 142, t. 8) and shackle, rete for 27 stars, 5 plates, alidade, pin and horse. The ring is missing.

Front

There is a fine shackle which has trifoliate outline and an oval cross-section and ornate bases. The *kursī* is worked à jour and has a trifoliate finial.

The limb is divided into 1° and 5° and groups of 5° are numbered from 5 to 360°. But at the back the altitude scale is divided in 1° and 6°.

Rete

The Capricorn ring and the much broader ecliptic ring are held together by the equinoctial bar which has counter changes at its two intersections with the ecliptic ring. The tracery joining the star pointers is quite symmetrical. Inside the ecliptic ring, it forms a heart-shaped frame around the star pointer of Vega. The ecliptic ring is divided into the 12 signs, labelled with their names; further subdivided into 6° and labelled. These divisions are marked on the beveled edge. There are 27 named star pointers. The

rete is broken at three places and mended. There is a handle on the Capricorn ring, to the right of the north point.

Figure A041.2 – Rete of the Astrolabe (photo by S. R. Sarma)

PLATES

There are five plates.

Table A041-1 Plates

	φ	Longest Day
1a	22°	13 hours!
1b	25°	13 hours!
2a	27°	13;43 hours
2b	32°	14;8 hours
3a	36°	14;32 hours

	φ	Longest Day
3b	40°	14 hours !
4a	42°	14 hours
4b	0°+72°+90°	
5a	Tablet of ecliptic co-ordinates	
5b	Tablet of horizons	

On plates 1-4 altitude circles are drawn for every 6° and labelled on both sides. Azimuth arcs are drawn for 10° below the horizon. On 3b for 40°, however, they are drawn above and below the horizon. Lines for seasonal hours are drawn on all latitude plates. On plate 3a-b (36°-40°), lines are drawn for equal hours from the western horizon; on the rest they are drawn from the western as well as the eastern horizon up to the meridian. The duration of the longest day is erratic in several cases.

As mentioned above, the rims of all plates are engraved with gazetteers of 16 places. As an example, the gazetteer engraved on the rim of the plate 2a for latitude 27° will be reproduced below, as much as it was possible to decipher. The gazetteer starts from the north point and proceeds clockwise.

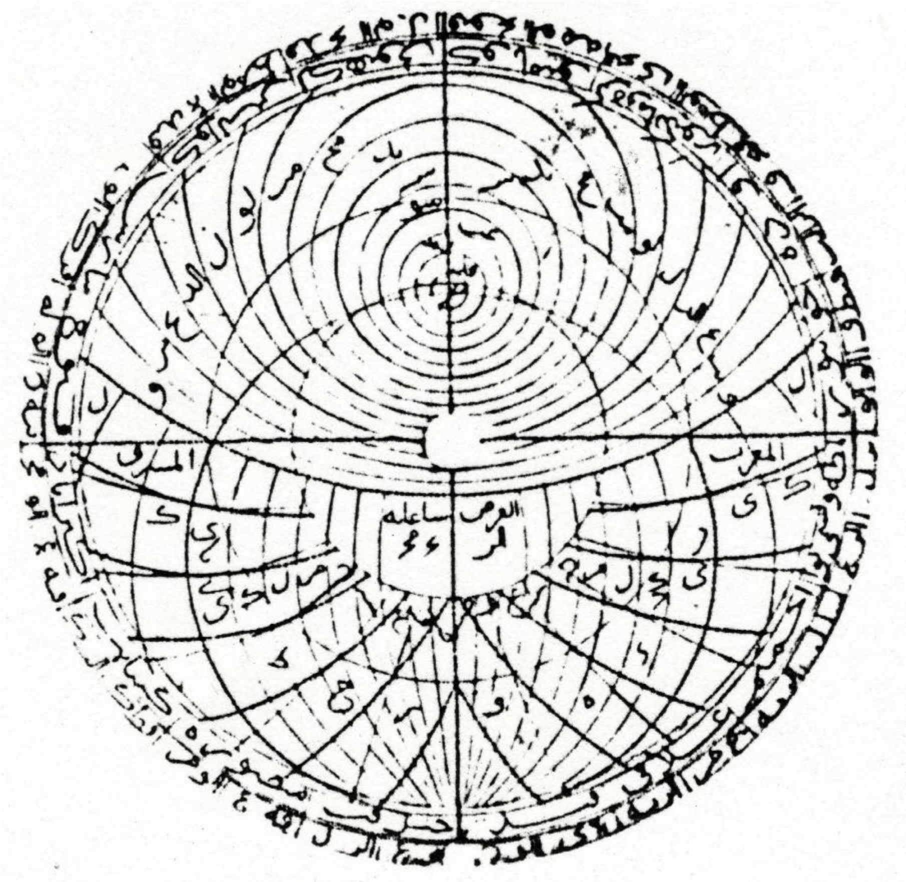

Figure A041.3 – Plate for latitude 27° (from Christie's catalogue)

Table A041-2 Gazetteer on Plate 2a

	Place Name	L	φ
01	---	---	27;30
02	Mansūrah	105;0	27;40
03	---	59;20	27;20
04	Akbarābād	115;-	26;43
05	Qannawj	115;50	26;45
06	Banāras	107;20	26; ?
07	Kowaliyar	114;0	26;49
08	Lakhnauti	114;13	26;30
09	Kopāmāū	116;13	26;45
10	Karah wa Manikpūr	113;10	26;49
11	Awadh	113;6	27;22

	Place Name	L	φ
12	Jawnbūr	119;6	26;26
13	---	---	27;0
14	Ajmīr	-;30	26;15
15	Allāqī	68;40	27;15
16	Fayd	---	26;50

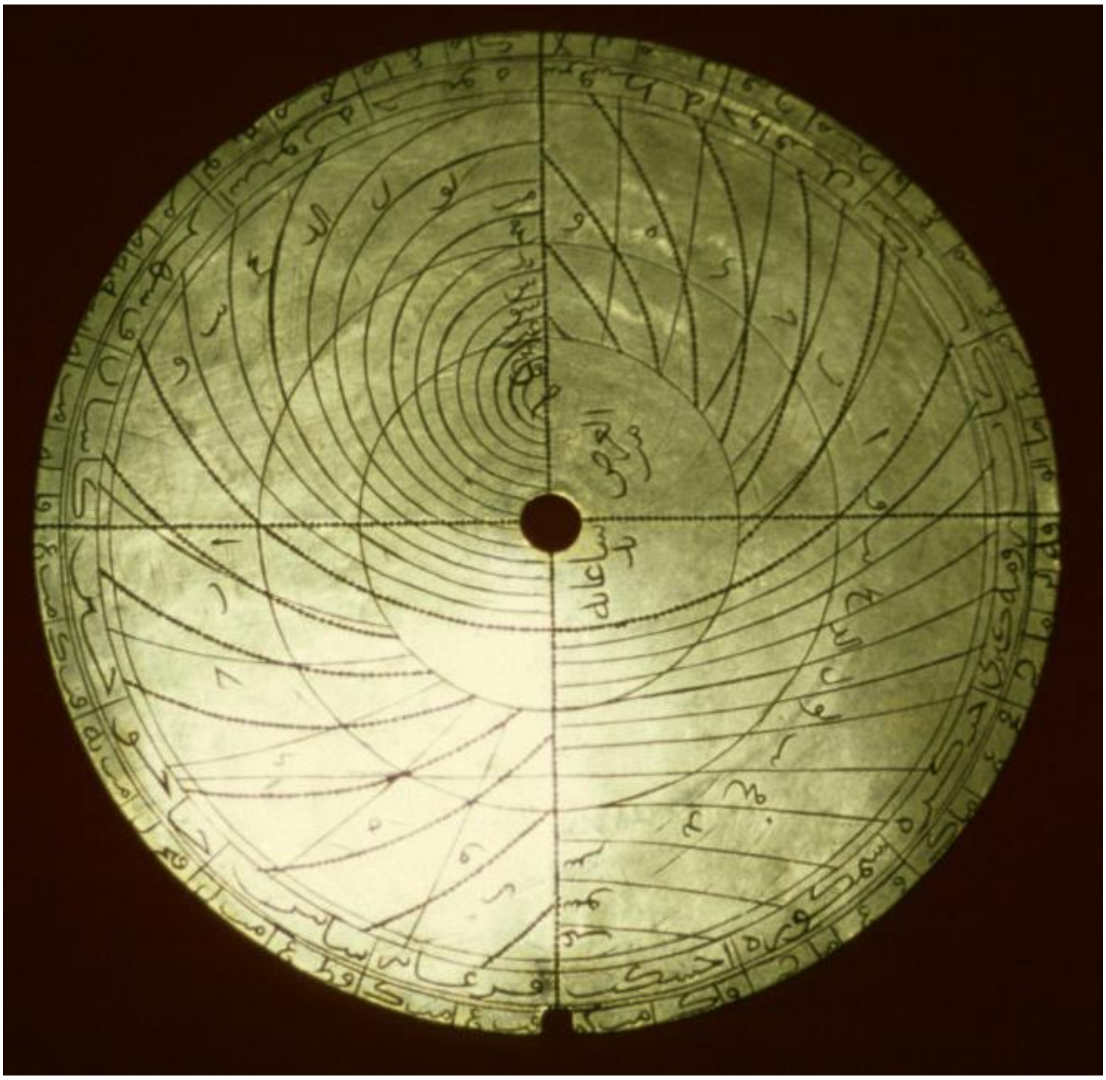

Figure A041.4 – Plate for the latitude of 42° (photo by S. R. Sarma)

On plate 4a for the latitude of 42°, the astrolabe maker shows off his virtuosity by interchanging the upper and the lower quadrants on the right. Here also the rim carries a gazetteer of 16 places that are stuated near the latitude of 42° such as Farghāna,

Rūmiyya Kabīrī (Rome), Khutan, Jenowa (Genoa) and so on. On the reverse side of the plate is a combined projection for the three latitudes of 0° + 72° +90°. On the rim, however, are listed 16 localities close to the equator.

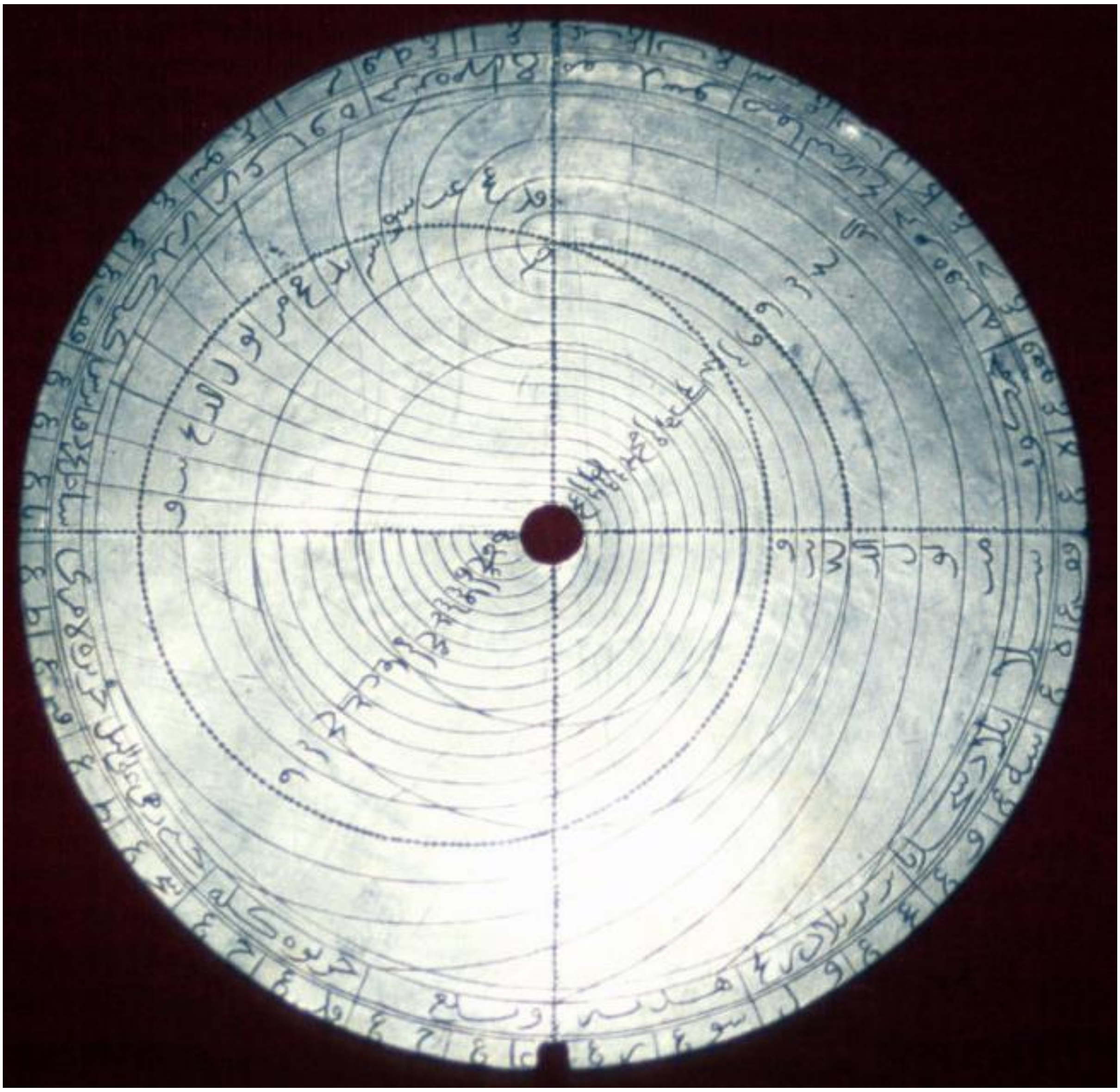

Figure A041.5 – Combined projection of latitudes 0° + 72° + 90° (photo by S. R. Sarma)

GEOGRAPHICAL GAZETTEER

On the inner side of the mater, a geographical gazetteer of 69 localities is engraved in a spiral form. The order of arrangement is: place name (*al-bilād*), latitude (*al-ᶜarḍ*) and longitude (*al-ṭūl*). There is a peg at the north point to prevent the plates from rotating freely around the centre.

BACK

The rim of the upper half carries two altitude scales, divided in 1° and 6° and numbered as 6—90; 90—6, while the rim of the lower half has scales of cotangents.

The upper left quadrant carries a sine-cosine grid with 30 horizontal and 30 vertical parallels, where each third line is highlighted by a dotted line.

In the upper right quadrant are drawn six declination circles; the serial numbers of the related signs are marked along the two radii. On these arcs, two graphs are drawn for the solar meridian altitude for the latitudes of 27° and 32°.

In the lower half are shadow squares, on the left for the base of 12 digits and on the right for the base of 7, with the scales divided and numbered accordingly. The scales are accompanied by the following labels:

Vertical scale on the left: *ẓill sullam aṣābiᶜ maᶜkūs*
Horizontal scale on the left: *ẓill sullam aṣābiᶜ mustawī*
Horizontal scale on the right: *ẓill sullam aqdām mustawī*
Vertical scale on the right: *ẓill sullam aqdām maᶜkūs*

Figure A041.6 – Back of the astrolabe (photo by S. R. Sarma)

Within the shadow squares is a table of climates, displaying the latitudes and the hours of the maximum daylight at the beginning and the middle of the seven climates.[313]

313 This table occurs also in A024 and A051, but in different arrangements. See also Kaye 1918, p. 132

Here the first column shows the climates, the second the latitude at the beginning (*mabdā'*) of the climate and the third the latitude at the middle (*wasaṭ*) of the climate. In the fourth column are mentioned the maximum hours of daylight at the beginning of the climate and in the fifth column the same at the middle of the climate. For the seventh climate, the second column shows both the latitudes at the beginning and end of the climate; likewise, the fourth column displays maximum hours at the beginning and end of the climate.

Table A041-3 Climates

***Aqālīm* (climates)**	***ᶜarūḍ* (latitudes)**		***sāᶜāt* (hours)**	
	beginning	middle	beginning	middle
1	12;43	16;47	12;45	13;0
2	20;31	24;10	13;15	13;30
3	27;34[314]	30;46	13;45	14;0
4	33;43	36;28	14;15	14;30
5	39;1	41;21	14;45	15;0
6	43;30	45;39	15;15	15;30
7	47;18 50;31	48;59	15;45 16;15	16;0

ALIDADE

The alidade is 98 mm long with ornate ends and an ornate centre piece. The pin and the horse are replacements.

INSCRIPTION

Immediately below the horizontal diameter is the maker's signature which reads

ṣanᶜat aḍᶜaf al-ᶜibād muḥammad muqīm ibn 'īsā ibn allāhdād lāhūrī [asṭurlābī] humāyūnī

---

314 Inscribed wrongly as 24;34.

> ‘The work of the weakest of the servants [of God], Muḥammad Muqīm, son of ‘Īsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.’

BIBLIOGRAPHY

The astrolabe was shown on the cover page of Christie’s Catalogue, *Engineering and Scientific Works of Art and Instruments*, London 21 March 1991, but was not described inside, nor was it included in the auction. But it came up for auction at some other time: I have two sheets from a catalogue, showing all parts front and back, with numbers K 39564 and K 39565.

A042⊙ ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED

Diameter 105 mm

Paris, Institut du Monde Arabe (#AI 86-25)

CCA 3537

Figure A042.1 – Front of the astrolabe (photo courtesy Institut du Monde Arabe)

This small astrolabe has an unusual *kursī.* It is solid and plain, yet it is striking with its extravagant profiles having lobed protuberances. On the back, instead of the usual two graphs of the midday altitude of the sun at the latitudes of the Mughal Imperial cities Agra (27°) and Lahore (32°), there is only one graph for 32°.

COMPONENTS

Body with *kursī* (d. 105, h. 141, t. 7), shackle and ring, rete for 37 stars, 5 plates (d. 89), alidade, pin and washer. Original horse is missing; a pin is used a substitute.

FRONT

The ring has a diamond cross section. The shackle has trifoliate shape but simple round bases. The *kursī* is solid without any fretwork or surface decorations; but is endowed with unusual profiles with three tri-lobed protuberances.

The limb is divided in 1° and 6° and numbered in 6s from 6 —360.

RETE

The Capricorn ring and the ecliptic ring are held together by the equinoctial bar counter-changed once at the centre; the spaces between the two rings and inside the ecliptic circle are filled with a floral tracery of continuous flow of vines and tendrils, with the recurring motif of tulips with flared petals. Particularly impressive is the spiral form of the tracery inside the ecliptic ring. A large handle is attached to the Capricorn ring at NW. The ecliptic circle is divided into 12 signs of zodiac and labelled with their names; each sign is divided into five units of 6° each and numbered accordingly. There are 37 star pointers.

Figure A042.2 – Rete of the astrolabe (photo by S. R. Sarma)

Table A042-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab Qayṭus Janūbī*	β Ceti
2	*Baṭn Ḥūt*	β Andromedae
3	*Fam Qayṭus*	γ Ceti
4	*Ṣadr Qayṭus*	π Ceti
5	*Ghūl*	β Persei
6	*Masāfat al-Nahr*	γ Eridani
7	*ʿAyn Thawr*	α Tauri

	Star Name	Identification
8	*ᶜAyyūq*	α Aurigae
9	*Rijl Jawzā' Yusrā*	β Orionis
10	*Yad Jawzā' Yusrā*	γ Orionis
11	*Yad Jawzā' Yumnā*	α Orionis
12	[*Shiᶜrā*] *Yamānī*	α Canis Majoris
13	[*Shiᶜrā*] *Shāmī*	α Canis Minoris
14	*Fard Shujāᶜ*	α Hydrae
15	*Qā'idāt Bāṭiya*	α Crateris
16	*Janāḥ Ghurāb*	γ Corvi
17	*Ẓahr Dubb Akbar*	α Ursae Majoris
18	*Simāk Aᶜzal*	α Virginis
19	*ᶜAnāq*	ζ Ursae Majoris
20	*Simāk Rāmiḥ*	α Bootis
21	*Fakka*	α Coronae Borealis
22	*ᶜUnuq Ḥayya*	α Serpentis
23	*Qalb ᶜAqrab*	α Scorpii
24	?	ρ Ophiuchi
25	*Jāthī*	α Herculis
26	?	δ Ophiuchi
27	*Nasr Wāqiᶜ*	α Lyrae
28	*Minqār Dajāja*	β Cygni
29	*Nasr Ṭā'ir*	α Aquilae
30	*Dhanab al-Dajāja*	α Cygni
31	*Fam Faras*	ε Pegasi

	Star Name	Identification
32	*Dhanab Jadī*	α Capricorni
33	*Mankib Sākib Mā’*	α Aquarii
34	*Sāq Sākib Mā’ Janūbiyya*	δ Aquarii
35	*Mankib Faras*	β Pegasi
36	?	?
37	*Khadīb*	β Cassiopeiae

PLATES

There are five plates with the following specifications.

Table A042-2 Plates

	φ	Longest Day
1a	22°	13;22 hours
1b	25°	13;25 hours
2a	27°	13;43 hours
2b	32°	14;8 hours
3a	36°	14;28 hours
3b	40°	14;52 hours
4a	18°+70° double projection	
4b	0°+90° double projection	
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

Altitude circles are drawn at every 6°; azimuth arcs for 10° sometimes above and sometimes below the horizon. There are lines for seasonal hours and for equal hours. Each plate has a rectangular notch at the north point.

Geographical Gazetteer

A gazetteer of 58 localities is engraved on the inner surface of the mater in two circles which are separated by a blank circle bounded on either side by double lines. A similar black circle also separates the first circle from the inner edge of the limb.

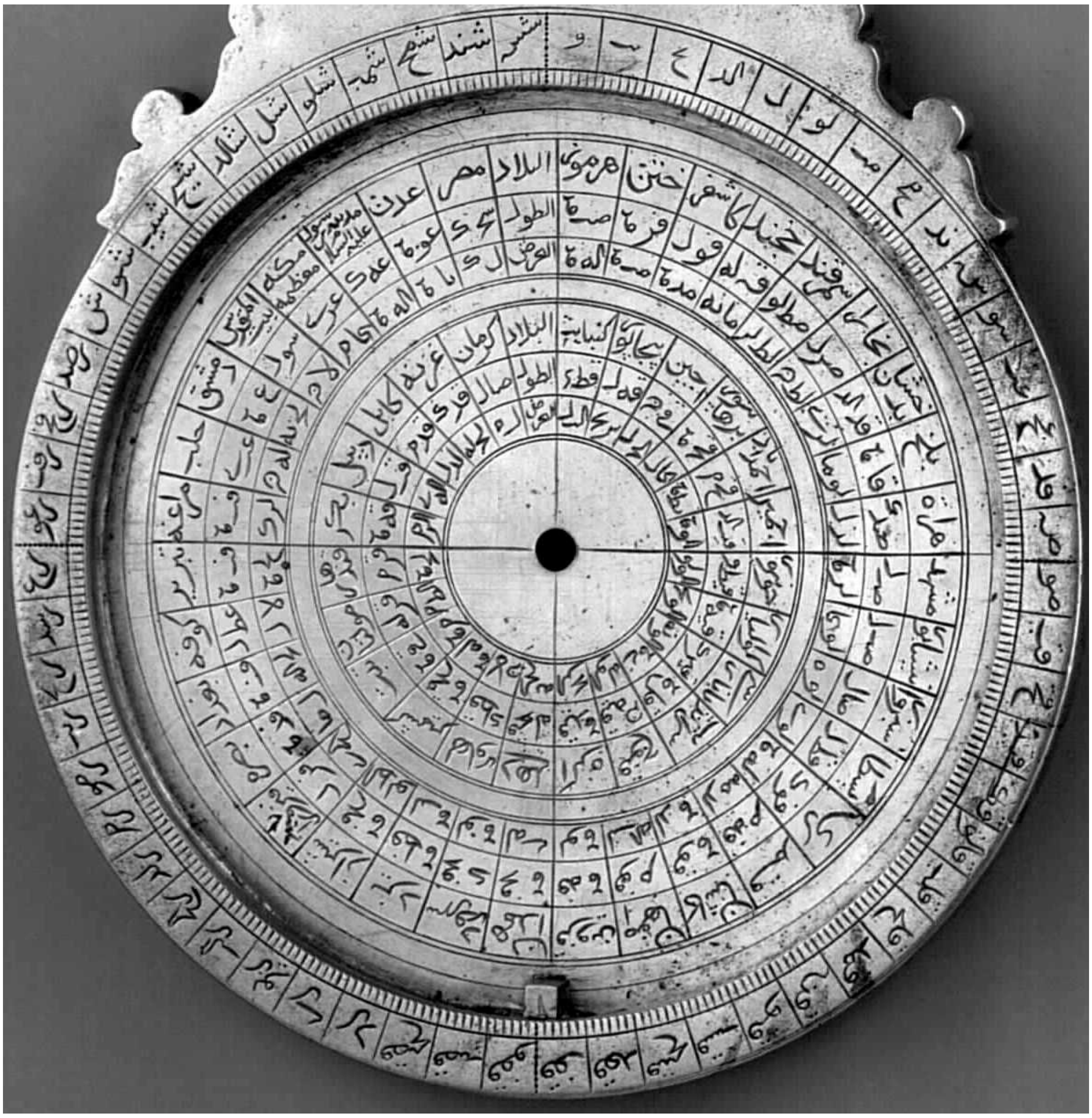

Figure A042.3 – Geographical Gazetteer (photo courtesy Institut du Monde Arabe)

Table A042-3 Geographical Gazetteer

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
	Outer Circle		
1	Miṣr	63;20	30;20
2	ᶜAdan	76;0	11;0

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
3	Madīnat Rasūl ᶜAlayhi al-Salām	75;20	25;0
4	Makka Muᶜaẓẓam	77;10	21;40
5	Bayt al-Maqdis	66;30	31;50
6	Dimashq	70;0	33;15
7	Ḥalab	72;10	35;50
8	Marāgha	82;0	37;20
9	Tabrīz	82;0	38;0
10	Kūfa	79;30	31;30
11	Baghdād	80.0	33;25
12	Baṣrah	84;0	30;41
13	Fīrūzābād	87;30	28;10
14	Shīrāz	88;0	29;36
15	Yazd	89;0	32;0
16	Suhraward	83;20	36;0
17	Hamadān	83;0	35;10
18	Qazwīn	85;0	36;0
19	Iṣfahān	86;40	32;25
20	Kāshān	86;0	34;0
21	Qumm	85;40	34;45
22	Rayy	86;20	35;0
23	Bisṭām	89;30	36;10
24	Sabzawār	91;30	36;5
25	Nīshābūr	92;30	36;21

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ʿarḍ*
26	Mashhad	92;30	37;0
27	Harāt	94;20	37;30
28	Balkh	101;0	36;41
29	Badakhshān	104;24	37;10
30	Bukhārā	97;30	39;50
31	Samarqand	99;36	39;37
32	Khujand	100;35	41;55
33	Kāshghar	106;30	44;0
34	Khutan	107;0	42;0
35	Hurmūz	92;0	25;0
	Inner Circle		
36	Kirmān	91;30	30;5
37	Ghazna	104;20	33;35
38	Kābul	104;40	34;30
39	Dabīl	102;30	25;10
40	Bakr	105;0	27;40
41	Qandahār	107;40	33;0
42	Mūltān	107;35	29;40
43	Tubbat	110;0	40;0
44	Kashmīr	108;0	35;0
45	Lahāwar	109;20	31;50
46	Dihlī	113;35	28;15
47	Akra	114;0	27;13
48	Qannawz	115;50	26;35

	Place Name *al-bilād*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
49	Sarāndīp	130;0	10;0
50	Bānārasī	117;20	26;55
51	Kawāliyār	115;0	26;13
52	Jawnbūr	119;6	27;37
53	Ajmīr	112;24	26;0
54	Aḥmadābād	108;40	19;0
55	Burhānpūr	103;0	21;30
56	Ujjayn	110;50	23;30
57	Bījāpūr	105;30	17;13
58	Kanbāyat	109;4	22;30

BACK

The rim of the upper half carries altitude scales divided in 1° and 6° and labelled in 6s as 6—90; 90—6. On the upper left is a trigonometric quadrant with 30 horizontal parallels, with every third line highlighted by dots.

In the upper right, a universal horary quadrant is superimposed on the solar quadrant. In the solar quadrant, six declination arcs are drawn and the related signs are marked by their serial numbers along the two radii. Instead of the usual two, only a single graph of the solar meridian altitude is drawn for the latitude 32° with the label *khaṭṭ niṣf al-nahār bi-ᶜarḍ 32*. Six lines of seasonal hours are drawn in the same quadrant and numbered from 1 to 6.

Figure A042.4 – Back of the astrolabe (photo courtesy Institut du Monde Arabe)

In the lower half are drawn the shadow squares in the lower half; on the left for 7 feet with the two scales divided in 7 units and numbered serially; on the right for 12 digits with the two scales divided in 6/12 units and numbered in 2's as 2, 4, …12. The labels are:

Vertical scale on the left: *ẓill sullam aqdām maᶜkūs*

Horizontal scale on the left: *ẓill sullam aqdām mustawī*
Horizontal scale on the right: *ẓill sullam aṣābi^{c} mustawī*
Vertical scale on the right: *ẓill sullam aṣābi^{c} ma^{c}kūs*

Outside the shadow squares, but inside the rim, are two semi-circular rows with the names of the 12 zodiac signs engraved in one and the names of 28 lunar mansions engraved in the other.

The rim on the lower half carries cotangent scales. The scale on the left is marked with 6, 12, 18, 24, 30, 36, … 60, *al-aqdām.* The scale on the right is marked with the same numbers followed by *al-aṣābi^{c}*.

ALIDADE

Straight bar alidade with unusual ornate ends and an ornate centre-piece; the edge of the right half is graduated in divisions corresponding to the distances between the horizontal parallels in the sine quadrant, which are numbered on the surface, in 6s, from 6, 12…60. There are also sundial markings for hours 1/12, 2/11, 3/10, 4/9 and 8. On the left half is engraved the scale of solar longitude with curves matching the pairs of signs in the upper right quadrant together with their serial numbers.

INSCRIPTION

Within the shadow squares is engraved the maker's signature in three lines upside-down:

> *aḍa^{c}af al-^{c}ibād muḥammad muqīm ibn mullā*
> *^{c}īsā ibn shaykh allāhdād [a]sṭurlābī*
> *humāyūnī lahūrī.*
>
> '[Made by] the weakest of the servants [of God], Muḥammad Muqīm, the son of Mullā ^{c}Īsā, the son of Shaykh Allāhdād of Lahore, the astrolabe-maker to [the Emperor] Humāyūn.'

PROVENANCE

Formerly in the M. Distombes Collection

Bibliography

Mouliérac 1989, pp. 102-104.

A043 ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED

Diameter 96 mm

Cannes, PC

Répertoire 34

The Répertoire gives the following information about this astrolabe.

RETE

The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names; 22 named star pointer.

GEOGRAPHICAL GAZETTEER

Names, longitudes and latitutides of (?) localities.

BACK

Upper half of the rim carries the altitude scales divided in 2° and 5° and the lower half cotangent scales. Upper left quadrant carries a sign graph; upper right quadrant bears arcs of declination and two curves for the midday altitude of the sun at latitudes 27° and 32°. Lower half has shadow squares and astrological tables.

INSCRIPTION

sanacahu muḥammad muqīm ibn cīsā ibn allāhdā[d] aṣ[ṭ]urlābī humāyūnī lāhūrī.

'Made by Muḥammad Muqīm, son of cĪsā, son of Allāhdā[d] of Lahore, astrolabe maker to [the Emperor] Humāyūn.'

PROVENANCE

Private collection at Cannes; formerly of the private collection of Palmö, Bombay.

A044 ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED[315]

Diameter 92 mm

PLU

Figure A044.1 – Front of the astrolabe (photo from Linton 1980)

315 Entry based on Linton 1980, no. 223, p. 175.

In this astrolabe, the workmanship appears to be good, but not the quality of engraving. In the degree scales on the front and on the back, the divisions of 1° are very irregular. The Linton Catalogue remarks: ‘Not one of Muḥammad Muqīm’s best astrolabes! The engraving of the Arabic is often crude and done without understanding, but this instrument does not appear to be modern, fake. Possible apprentice work from the Lahore workshop.’

COMPONENTS

Body with *kursī* (d. 92), shackle and ring, rete for 16 stars, 5 plates, alidade, washer, pin and wedge.

FRONT

The *kursī* is heavily reticulated. From the available photos, it is not clear whether there is trifoliate finial. The limb is divided in 1° and 6° and numbered from 6 to 90, separately in each quadrant.

RETE

The rings of the Capricorn and ecliptic are held together by the horizontal bar which has no counter-change and by an indifferent tracery which connects the star pointers to the main frame.

PLATES

There are 5 plates serving latitudes 18°+30° and 25°; 20°and 30°; 0°+72°+90°and 29°; 36°and 40°; tablet of ecliptic coordinates and tablet of horizons. Azimuth arcs are sometimes engraved below the horizon. There are lines for seasonal hours and for equal hours drawn from the western horizon. Curves for the midday altitude of the sun at latitudes of 27° (Agra) and 32° (Lahore) are drawn on the back, but surprisingly there are no plates for these latitudes.

GEOGRAPHICAL GAZETTEER

The geographical gazetteer provides the names, longitudes and latitudes of 42 localities.

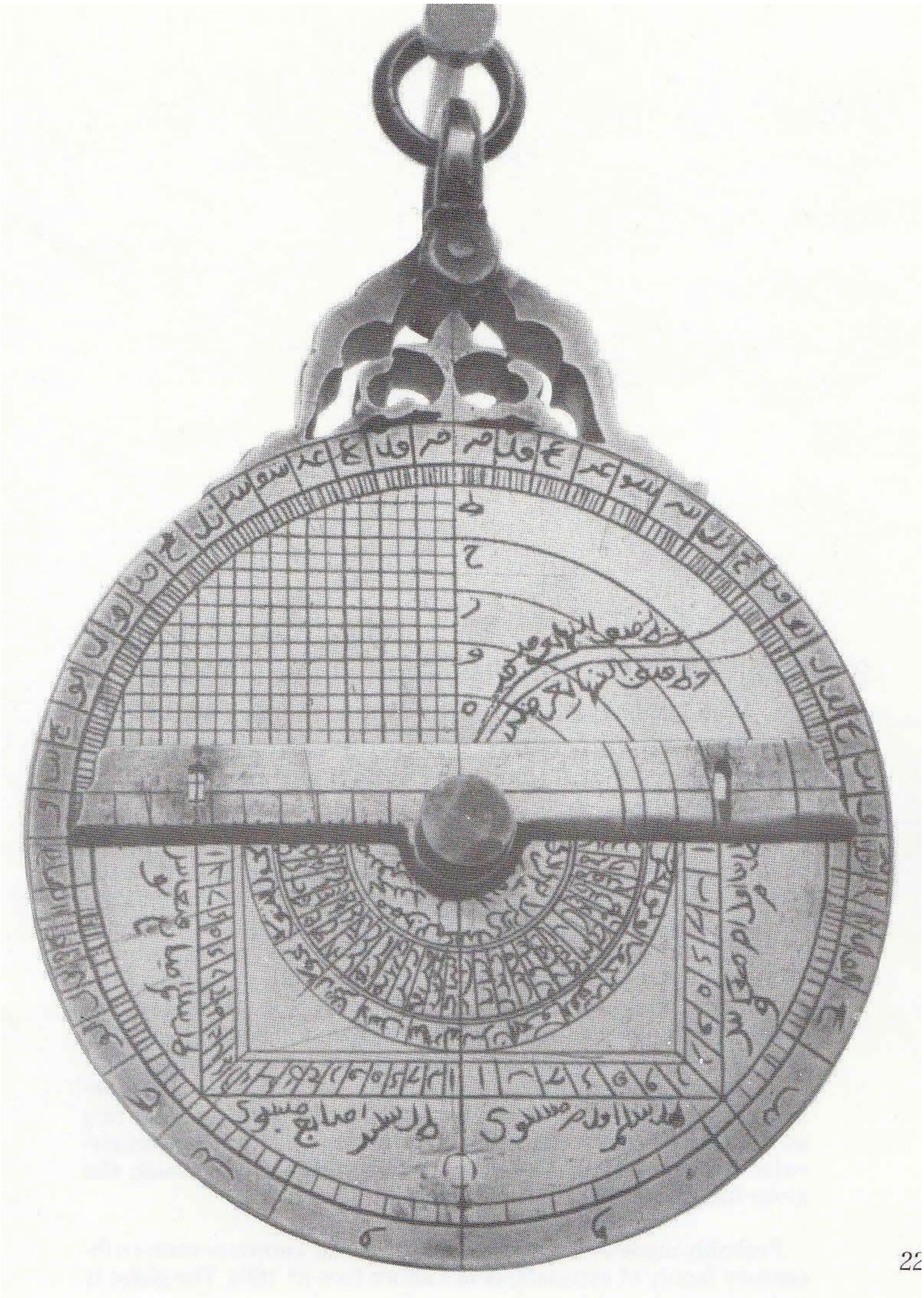

Figure A044.2 – Back of the astrolabe (photo from Linton 1980)

BACK

The upper half of the rim carries altitude scales divided in 1° and 6° and numbered in 6s as 6—90 and the lower half the cotangent scales, on the left in digits and on the right in feet. Trigonometric quadrant in the upper left with 20 horizontal and 20 parallel

lines. Solar quadrant in the upper right with declination arcs for each 30° of solar longitude, the vertical and horizontal radii marked with the serial numbers of the signs, and two sigmoid graphs of the sun's meridian altitude at the latitudes 27° and 32° with the usual labels.

In the lower half shadow squares, on the left for a base of 12 and on the right for a base of 7. The vertical and horizontal scales are divided and numbered accordingly and accompanied by the usual labels.

Within the shadow squares, two semi-circular rows showing the relation between the 12 zodiac signs and the 28 lunar mansions.

INSCRIPTION

The maker's signature is engraved in the space between the horizontal diameter and the semi-circular rows.

> *sanaᶜahu muḥammad muqīm ibn ᶜīsā ibn allāhdād asṭurlābī lāhūrī humāyūnī*
> 'Made by Muḥammad Muqīm, son of ᶜĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.'

PROVENANCE

Formerly in some private collection. Came up for auction at Nouveau Drouot, Paris, on 9 and 10 October 1980.

BIBLIOGRAPHY

Linton 1980, no. 233, p. 175.

A045 ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED

Diameter 92 mm

Fontenay-le-Comte, PC

Répertoire 35

RETE

The rete carries 16 named star pointers; there are five plates. The inscription on the back reads:

> *san^{c}at muḥammad muqīm [ibn ^{c}īsā] ibn allāhdād asṭurlābī lāhūrī humāyūnī*
>
> '[Made by], Muḥammad Muqīm, son of ^{c}Īsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.'

In the Arabic/Persian version cited in the Répertoire*,* the words 'ibn Isa', are missing, but not in the translation!

A046 ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED

Diameter 90 mm

PLU

Répertoire 28

RETE

The rete has 37 named star pointers; there are 6 plates. The inscription on the back reads:

> *aḍcaf al-cibād muḥammad muqīm ibn mullā cīsā*
> *ibn shaykh allāhdād asṭurlābī*
> *lāhūrī humāyūnī*
>
> '[Made by] the weakest of the servants [of God], Muḥammad Muqīm, son of Mullā cĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.'

A047 ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED[316]

Diameter 90 mm

PLU, Ex-Paris, Sottas

CCA 1119; Répertoire 24

Figure A047.1 – Front of the astrolabe (photo courtesy Professor David King)

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316 Entry based on Sottas 1930.

In designing the *kursī* of this astrolabe, Muqīm makes a departure from the characteristic style of his family and opts for a very plain surface with two prominent eyelets as in the Kufic astrolabes of the Middle East. But the rete retains its ornate character. There are plates with composite projections for latitudes 0° + 72° + 90° and for 18° + 72 ° to be found in other astrolabes as well, but this is perhaps the only astrolabe which contains a plate with projections for latitude 72°. In the plate for 32°, lines of equal hours are drawn also above the line of horizon, which is unusual.

COMPONENTS

Body with *kursī* (d. 90, t. 7), shackle and ring, rete for 37stars, 6 plates, alidade, pin and horse.

FRONT

The astrolabe has a large ring and a shackle, both with a diamond cross section. The shackle seems to have a trifoliate form. The *kursī* has lobed profiles and terminates in a trifoliate finial. A line runs all along the sides, emphasizing the eyelets.

The limb carries a scale of degrees divided in 1° and 6° and numbered from 6 to 90 separately in each quadrant.

RETE

The Capricorn ring and the ecliptic ring are held in position by the equinoctial bar with counterchanges at its two intersections with the ecliptic ring. A segment of the solstitial bar running between the two circles in the lower half is the base for a number of star pointers; from these arise two creepers to the left and to the right and then upwards, filling the space between the two rings. Inside the ecliptic ring, the two creepers start off from the centre, branch off and then join to create an empty space in the form of a stylized quatrefoil and then branch off to the left and right. These two creepers, almost symmetric, carry the 37 star pointers in the form of leaves or stylized tulip petals. The ecliptic circle is divided into 12 zodiac signs and labelled with their names. Each sign is divided into 5 units of 6° and numbered accordingly.

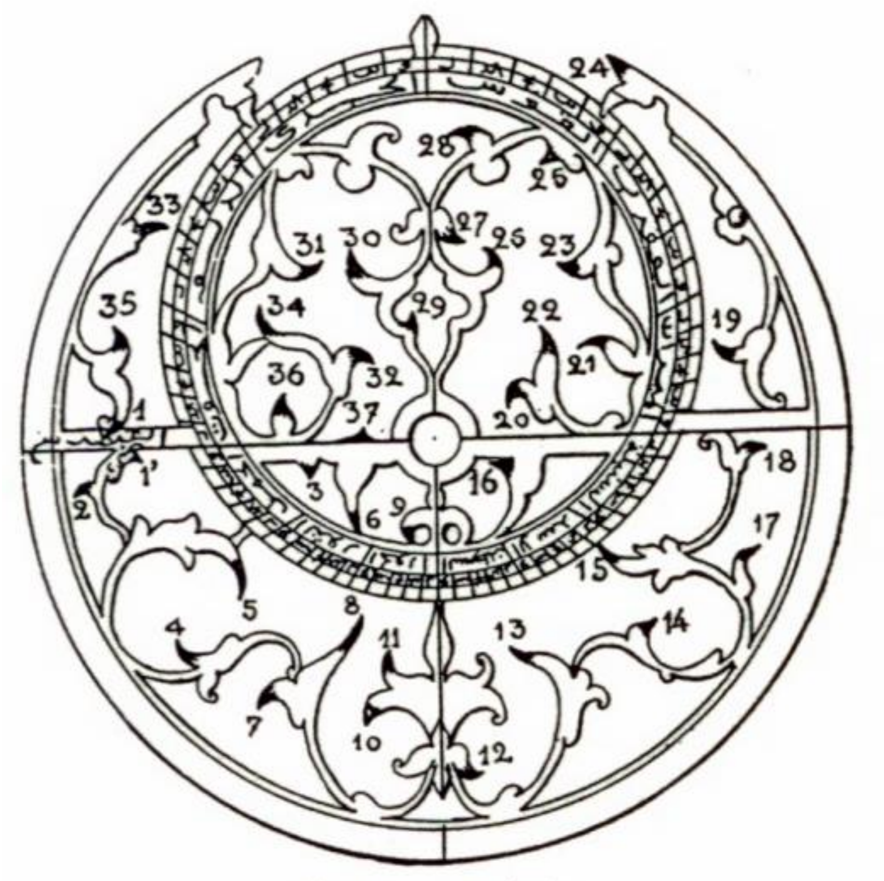

Figure A047.2 – Rete of the astrolabe (drawing from Sottas 1930)

There are 37 named star pointers in the rete. The names are difficult to read in the available photos. In his list, Dorn does not give the Arabic names, but only their French translation together with their identification. A summary of his star list is given in the following table

Table A047-1 Stars on the Rete

	Translation of the Arabic Name	Identification
1	The tail of the whale, northern	ι Ceti
2	The tail of the whale, southern	β Ceti
3	The belly of the fish	β Andromedae

	Translation of the Arabic Name	Identification
4	The breast of the whale	π Ceti[317]
5	The mouth of the whale	γ Ceti[318]
6	Algol	β Persei
7	The boatman of the interval of the river	γ Eridani
8	The eye of the bull	α Tauri
9	Goat ?	α Aurigae
10	The left foot of the giant	β Orionis
11	The left hand of the giant	γ Orionis
12	Sirius of Yemen	α Canis Majoris
13	Sirius of Syria	α Canis Minoris
14	The neck of the serpent	α Hydrae
15	The heart of the lion	α Leonis
16	The back of the Great Bear	α Ursae Majoris
17	The base of the bowl	α Crateris
18	The right wing of the raven	γ Corvi
19	The neglected support	α Virginis
20	The young goat	ζ Ursae Majoris
21	The support of the lancer	α Bootis
22	The radiant one of the crown	α Coronae Borealis
23	The neck of the serpent	α Serpentis

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317 Sottas 1930 identifies it as γ Ceti.

318 Sottas 1930 identifies it as α Ceti.

	Translation of the Arabic Name	Identification
24	The heart of the scorpion	α Scorpii
25	The knee of the serpent charmer	ζ Ophiuchi
26	The head of the kneeling one	α Herculis
27	The head of the serpent charmer	α Ophiuchi
28	The right hand of the serpent charmer	ν Ophiuchi
29	The falling [eagle]	α Lyrae
30	The flying [eagle]	α Aquilae
31	The tail of the dolphin	ε Delphini
32	The tail of the chicken	α Cygni
33	The tail of Capricorn	δ Capricorni
34	The mouth of the horse	ε Pegasi
35	The leg of Aquarius	δ Aquarii
36	The shoulder of the horse	β Pegasi
37	The coloured hand	β Cassiopeiae

PLATES

There are six plates with the following specifications as provided by Sottas.

Table A047-2 Plates

	φ	Longest day
1a	27°	13;46 hours
1b	32°	14;8 hours

	φ	**Longest day**
2a	28°	13;48 hours
2b	36°	14;24 hours
3a	21;12°	13;16 hours
3b	35°	14;22 hours
4a	40°	14;54 hours
4b	0°+72°+ 90°	
5a	72°	24 hrs
5b	23;12°	13;24,22 hrs
6a	Tablet of ecliptic coordinates	
6b	Tablet of horizons	

Of the plates calibrated to different latitudes, Sottas provides detailed descriptions and drawings of only 3 plates for the latitudes 28°, 32° and 40°. On all the plates the labels *al-mashriq* (east) and *al-maghrib* (west) are inscribed below the horizon in the east and west respectively.

On 1b for 32° are drawn altitude circles for every 6° azimuth arcs for every 10° below the horizon and the lines of seasonal hours. Lines of equal hours are drawn from the western horizon as usual below the line of horizon. In addition, lines of equal hours are drawn above the line horizon starting from the eastern horizon, which is very unusual. Both these sets are numbered from 1 to 12.

On 2a for 28° are drawn altitude circles for every 6°, azimuth arcs for every 10° above the horizon, lines of seasonal hours and lines of equal hours from the western horizon.

On 4a for 40° are drawn altitude circles for every 6°, azimuth arcs for every 10° below the horizon, lines of seasonal hours and lines of equal hours from the western horizon.

Therefore, it may be assumed that probably on all plates altitude circles are drawn for every 6°, azimuth arcs for every 10° sometimes below the horizon and sometimes

above the horizon and that all plates carried lines of seasonal hours and lines of equal hours drawn from the western horizon.

It is strange that the latitudes on plates 3a (21;12°) and 5a (23;12°) have precisely the same additional fraction of 12 minutes. Sottas does not make any comment on this peculiarity.

The tablet of ecliptic coordinates (Sottas, fig. 5) has latitude circles inscribed for every 6° and longitude circles for every 10°. The names of the zodiac signs are inscribed along the ecliptic. There is the label *mīzān ᶜankabū,*

On the tablet of horizons (Sottas, fig. 4) half horizons are drawn for latitudes ranging from 6° to 68° in four sets as follows:

6	14	22	…	62
8	16	24	…	64
10	18	26	…	66
12	20	28	…	68

Declination scales are drawn between the equator and the tropics at their four intersections with the horizontal and vertical diameters. They are divided in 2° and labelled in 6s as 6, 12, 18, 24. Below the scales drawn along the horizontal diameter between the equator and the Tropic of Capricorn is inscribed *mayl kullī janūbī* (maximum declination south). Below the scales drawn along the vertical diameter between the equator and the Tropic of Cancer is the label *mayl kullī shamālī* (maximum declination north).

Plate 4b (Sottas, fig. 6) carries combined projections for the three latitudes 0°, 72° and 90°.

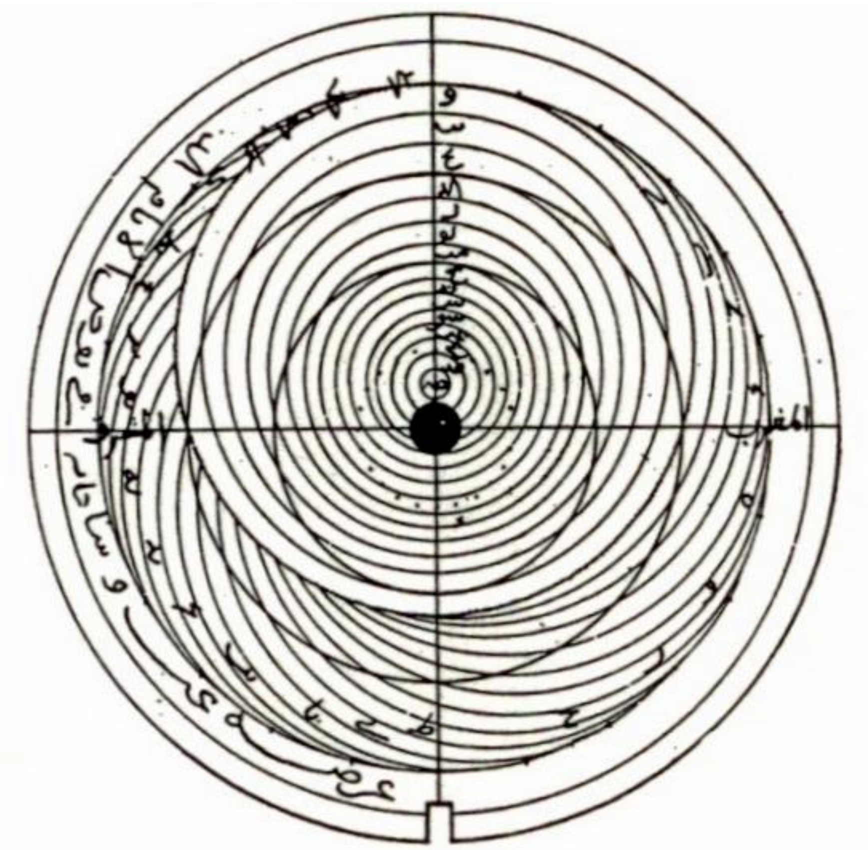

Figure A047.3 – Plate for latitude 72° (drawing from Sottas 1930)

Plate 5a bears stereographic projections for 72° (Sottas, fig. 8). This is perhaps the only astrolabe with a plate carrying stereographic projections for the arctic circle at latitude 72°. On this plate are drawn the vertical and horizontal diameters and the concentric circles of the tropics and equator. The horizon is shown as a full circle placed eccentrically, forming the boundary between the two sets of circles, viz. altitude circles drawn above/inside the horizon and the hour circes drawn below/outside the horizon. The line of the horizon cuts that of the equator at an angle of 18° and the horary circles cut the equator at the same angle.

The altitude circles are drawn for every 6° and numbered along the upper half of the vertical diameter. The hour circles are drawn from the western horizon and are numbered serially from 1 to 72.

On the eastern and western ends of the horizontal diameter are the labels *al-mashriq* (the east) and *al-maghrib* (the west) respectively. Outside the Capricorn circle, in the left half is a long label stating that the latitude is 72° and the longest day is 24 hours.

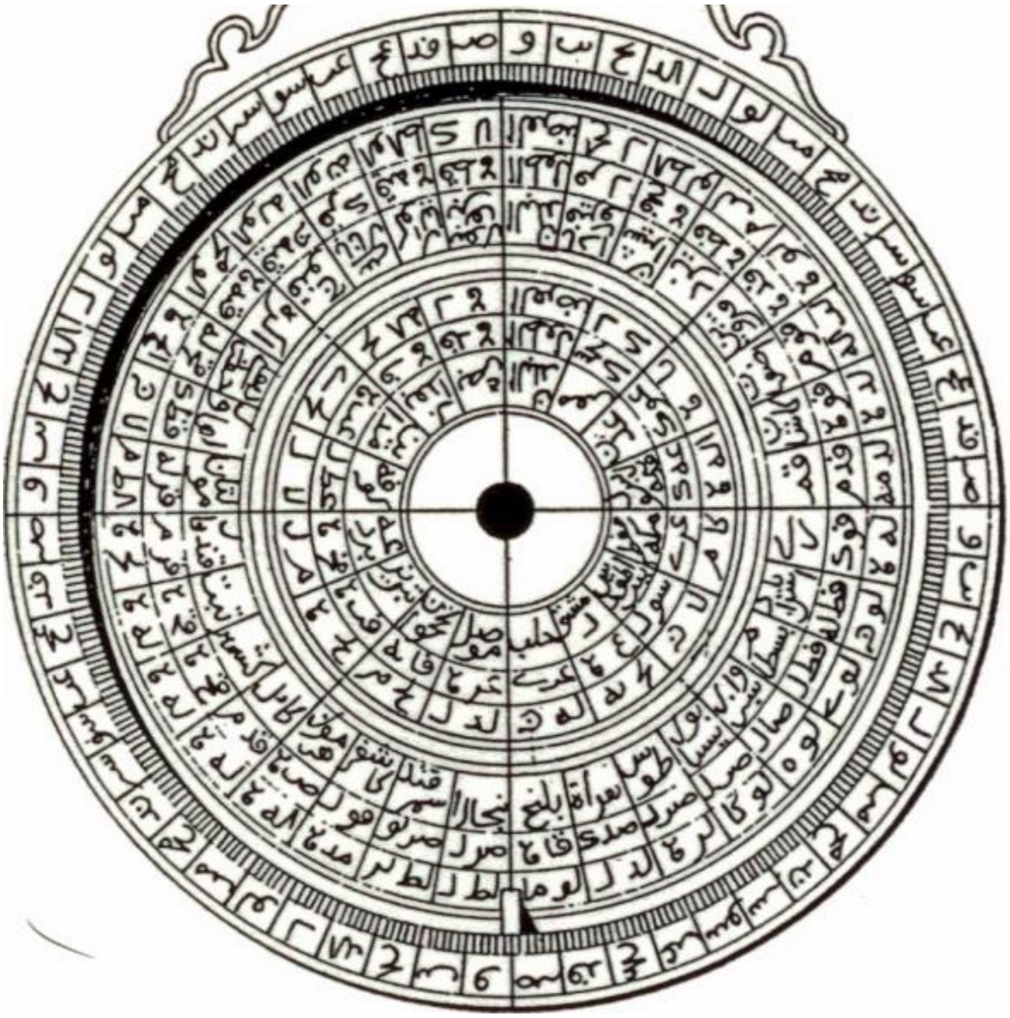

Figure A047.4 – Geographical Gazetteer (drawing from Sottas 1930)

GEOGRAPHICAL GAZETTEER

Gazetteer of 36 localities with their names, longitudes and latitudes engraved in two concentric circles. The letters are written upside down, the tops of the letters towards the centre of the astrolabe. The gazetteer commences in the inner circle, starting at the top centre and proceeds anticlockwise. Sottas (pp. 164-165) reproduces the gazetteer with the names of the localities in contemporary French spelling. The actual spelling in reproduced below. Sottas also drew a diagram of the gazetteer, but occasionally entered there wrong values. I have corrected these, as far as possible, with the help of a photo of the gazetteer.

Table A047-3 Geographical Gazetteer

	Place Name *Al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
	Inner Circle		
1	Miṣr	63;20	30;20
2	ᶜAdan	76;20	11;0
3	Madīnat Rasūl	75;20	25;0
4	Makka Muᶜaẓẓam	77;10	21;40
5	Bayt al-Maqdis	66;30	31;50
6	Dimashq	70;0	33;15
7	Ḥalab	72;10	35;50
8	Mawṣil	77;0	34;30
9	Nakhajwān	81;15	38;40
10	Tabrīz	82;0	38;0
11	Bardaᶜa	83;0	40;30
12	Kūfa	79;30	31;30
13	Madā'īn	72;0	33;10
14	Baghdād	80.0	33;25
15	Baṣra	84;0	30;0
	Outer Circle		
16	Fīrūzābād	87;30	28;30
17	Shīrāz	88;0	29;36
18	Yazd	89;0	32;40
19	Qazwīn	85;0[319]	36;0

[319] Sottas 1930 mentions 85;00 correctly in the table but transcribes it as 84;00 in the diagram.

	Place Name *Al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
20	Iṣfahān	86;40	32;25
21	Kāshān	86;0	34;0
22	Qumm	85;40[320]	34;45
23	Rayy	86;20	35;0
24	Astarābād	89;35	36;50
25	Bisṭām	89;30	36;10
26	Sabzawār	91;30	36;5
27	Nīsābūr	92;30	36;21
28	Ṭūs	92;30	37;0
29	Harāt	94;20	34;30
30	Balkh	101;0	36;41
31	Bukhārā	97;30[321]	39;50[322]
32	Samarqand	97;36[323]	39;37
33	Kāshghar	106;30	44;0
34	Hurmūz	92;0	25;0
35	Kābul	104;40	35;30
36	Kashmīr	108;0	35;0
37	Tubbat	110;0	35;0
38	Qandahār	107;40	33;0
39	Mūltān	107;35	29;40

320 Sottas 1930 mentions 85;40 correctly in the table but transcribes it as 84;40 in the diagram.

321 Sottas 1930 transcribes correctly 97;30 in the diagram but has 92;30 in the table.

322 Sottas 1930 transcribes wrongly 39;30 in the diagram but has 39;50 correctly in the table.

323 Sottas 1930 transcribes correctly 97;36 in the diagram but has 97;16 in the table.

	Place Name *Al-bilād*	**L** *al-ṭūl*	**φ** *al-ʿarḍ*
40	Lahāwar	109;20	31;50
41	Hadhrat Dihlī	113;35	28;0
42	Akra	115;0	26;43
43	Qannawj	115;50	26;35
44	Bānārasī	117;20	26;55
45	Kawāliyār[324]	115;0	26;29
46	Burhānpūr	109;0	20;31

324 Sottas 1930 explains that it is Kawahia (Cambaye); it is actually Gwalior.

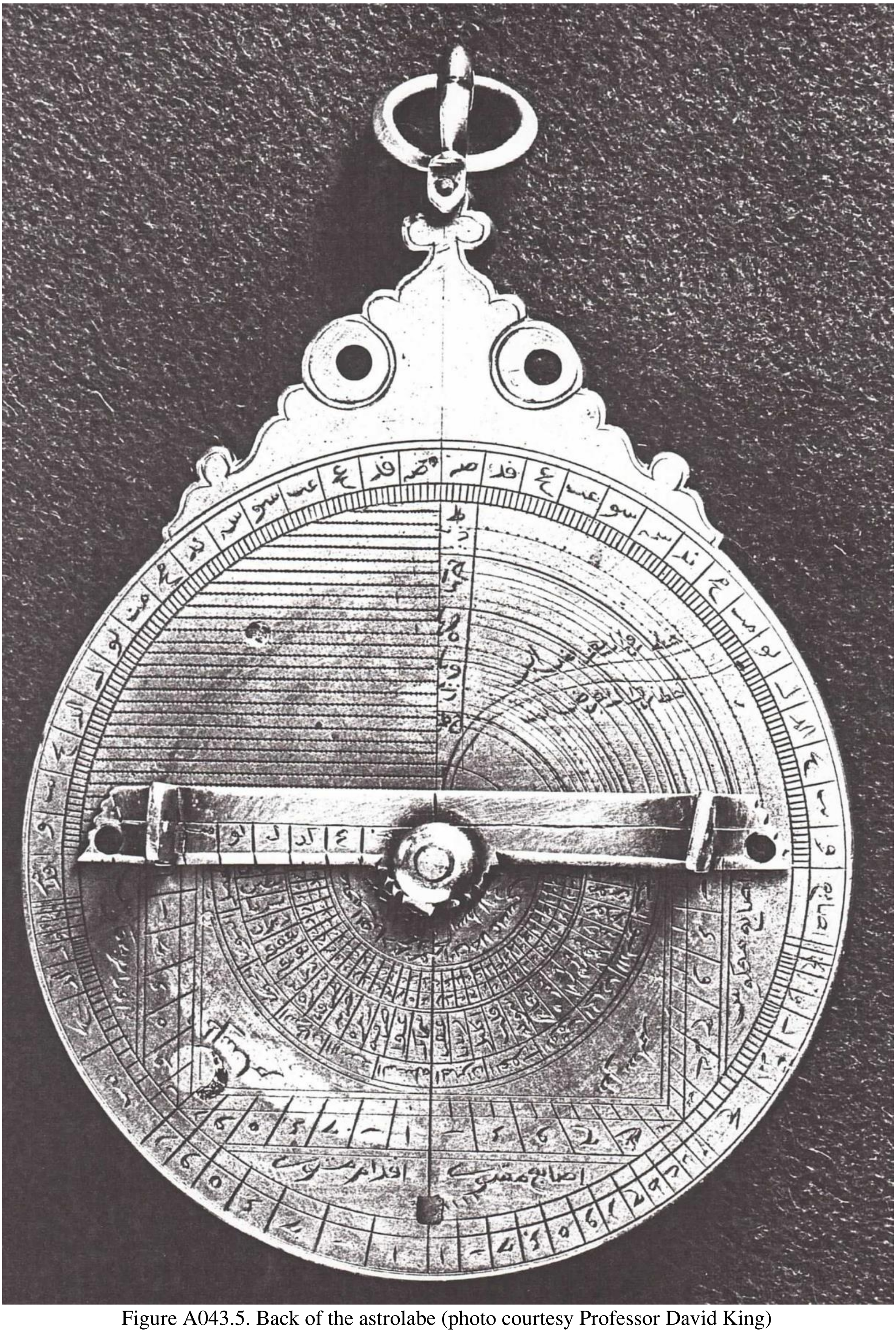

Figure A043.5. Back of the astrolabe (photo courtesy Professor David King)

Back

The rim of the upper half carries altitude scales, divided in 1° and 6° numbered in groups of 6° as 6—90; 90— 6. In the upper left is the trigonometric quadrant with 30 horizontal parallels as dotted lines.

Declination circles divide the upper right quadrant into 6 zones, each zone representing a pair of zodiac signs. The signs are marked by their serial numbers along both the radii. Dotted circles subdivide each zone into 5 subzones corresponding to 6° of solar longitude. Against this background are traced two sigmoid graphs of the median altitude of the sun at latitudes 27[325] and 32. Because of the limited space, the usual expression *niṣf al-nahār* (half of the day) is replaced by the shorter synonym *zawāl* (midday) in the labels. They read here *khaṭṭ zawāl bi-ᶜarḍ 27* and *khaṭṭ zawāl bi-ᶜarḍ 32* respectively.

Shadow squares are engraved in the lower half, on the left for the base of 7 and on the right for the base of 6 and 12. The scales on the left are divided in 7 parts and numbered from 1 to 7. The scales on the right are divided into 6 parts and numbered from 1 to 6. Each part is then halved so that there are 12 units in the scales. In both the corners on the left and right are engraved the words *ẓill sullam* which are to be read along with the labels on the outside of the scales.

Vertical scale on the left: [*ẓill sullam*] *aqadām maᶜkūs* (scale of reverse shadows in feet)

Horizontal scale on the left: [*ẓill sullam*] *aqadām mustawī* (scale of direct shadows in feet)

Horizontal scale on the right: [*ẓill sullam*] *aṣābiᶜ mustawī* (scale of direct shadows in digits)

Vertical scale on the right: [*ẓill sullam*] *aṣābiᶜ maᶜkūs* (scale of reverse shadows in digits)

Within the shadow squares are four semi-circular rows. The outermost row contains the names of the 12 zodiac signs followed by the names of the corresponding 28 lunar mansions in the next row. The next two rows are filled with the table of the decans and their regents.

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325 Sottas 1930 misread the number as 26 and reproduced the label accordingly in his drawing; see fig. 1 on p. 156 and the translation of the label on p. 157.

The rim on the lower half carries the cotangent scales. The divisions in the scale on the left are numbered as 1, 2, 3, 4, 5, 6, 7, 12, 18, 24, 30, 36, … 60, *aqdām.* The divisions on the scale on the right are numbered as 1, 2, 3, … 12, 18, 24, 30, 36, … 60, *aṣābi*ᶜ.

ALIDADE

The alidade has ornate ends and an ornate centre-piece. It is graduated only in the right half, with divisions that match the parallels in the trigonometric quadrant, and numbered in 6s from 6 to 60 starting from the centre.

INSCRIPTION[326]

> '[Made by] the weakest of the servants [of God], Muḥammad Muqīm, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.'

PROVENANCE

Between 1926 and 1930, the astrolabe was in the private collection of Dr Jules Sottas of Paris who sent a communication to the *Académie de Marine* in October 1926 which was published in 1930. In 1984 it was in private collection in Brussels and was exhibited there. Sometime between 1984 and 1996, the owner sold it back to a dealer in Paris.

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Anon 1984.

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326 Sottas 1930 did not reproduce the text of inscription but gave an inaccurate translation in French. The inscription cannot be read in the available photo.

A048 ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED

Diameter 80 mm

Hyderabad, Saidiya Library[327]

Figure A048.1 – Front of the astrolabe (photo by Ahmad Athaullah)

327 I am highly grateful to Ahmad Athaullah Saheb who took great pains to send me detailed photos of the instruments in this family library.

With a diameter of 80 mm, this is perhaps the third smallest astrolabe made by Muqīm. It is slightly worn out, but well preserved. The engravings are filled with a white material which turned into patina.

COMPONENTS

Body with *kursī* (d. 80, h. 112, t. 5) with shackle and ring, rete (d. 70) for 29 stars, 5 plates, alidade, pin. The original wedge is replaced by an S-shaped wire.

FRONT

The ring is well-crafted with a diamond cross-section and the shackle is trifoliate. Like the *kursī* in the previous astrolabe, the *kursī* here is rather plain with two eyelets prominently outlined. It terminates in a trifoliate finial. The limb is divided in 1° and in 6° and numbered in 6s as 6—360.

Figure A048.2 – Rete of the astrolabe (photo by Ahmad Athaullah)

RETE

The Capricorn ring and the much wider ecliptic ring are joined by the equinoctial bar which counterchanged at the centre. A segment of the solstitial bar runs down from

the ecliptic circle and branches off to the left and right into vines that bear the star pointers. The tracery of vines is asymmetric and is not continuous; it breaks off into several independent clusters. There are 29 named star pointers. The ecliptic ring is divided into the 12 signs of zodiac and labelled with their names. Each sign is subdivided into 5 units of 6° and numbered accordingly.

Table A048-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab Qayṭus J[anūbī]*	β Ceti
2	*Fam Qayṭus*	γ Ceti
3	*Ṣadr Qayṭus*	π Ceti
4	*Rās Ghūl*	β Persei
5	*Tālī Masāfat al-Nahr*	γ Eridani
6	*ᶜAyn Thawr*	α Tauri
7	*Rijl Jawjā' [Yusrā]*	β Orionis
8	*Yad Jawjā' [Yumnā?]*	α Orionis
9	*Rijl Jawjā' Yumnā*	κ Orionis
10	*Shiᶜrā Yamānī*	α Canis Majoris
11	*Shiᶜrā Shāmī*	α Canis Minoris
12	*Fard al-Shujāᶜ*	α Hydrae
13	*Qalb al-Asad* (?)	α Leonis
14	*Qāᶜidat Bāṭiya*	α Crateris
15	*ᶜAnāq*	ζ Ursae Minoris
16	*Janāḥ Ghurāb*	γ Corvi
17	*Simāk Aᶜzal*	α Virginis
18	*Simāk Rāmiḥ*	α Bootis
19	*ᶜUnuq Ḥayya*	α Serpentis

	Star Name	Identification
20	*[Nayyir] Fakka*	α Coronae Borealis
21	*Rās al-Ḥawwā'*	α Ophiuchi
22	*[Nasr al Waqi^c]*	α Lyrrae
23	*Minqār Dajāja*	β Cygni
24	*Dhanab al-Dulfīn*	ε Delphini
25	*[Dhanab Dajāja]*	α Cygni
26	*Dhanab al-Jadī*	δ Capricorni
27	*Mankib Sākib al-Mā'*	α Aquarii
28	*Fam Faras*	ε Pegasi
29	*Sāq Sākib al-Mā'*	δ Aquarii

PLATES

There are five plates serving the following latitudes:

Table A048-2 Plates

	φ	Longest Day
1a	22°	13;22 hours
1b	25°	13;25 hours
2a	27°	13;43 hours
2b	32°	14;8 hours
3a	36°	14;32 hours
3b	40°	14;54 hours
4a	18°+72° double projection	
4b	0°+90° double projection	
5a	Tablet of ecliptic coordinates	

	φ	Longest Day
5b	Tablet of horizons	

On plates 1-3, altitude circles are drawn for every 6° and labelled. Azimuths curves are traced for every 10° below horizons; on 3a above and below the horizon. Lines for seasonal hours are drawn on all the three plates. Lines for equal hours counted from the western horizon are drawn on 1a-b and 2a. Lines for equal hours since sunset and before sunrise are traced on 2b and 3a-b.

Plate 4 carries double projections of 18°+72° on the obverse and of 0°+90° on the reverse.

The tablet of ecliptic coordinates has circles of latitude for each 6° and circles of longitudes for each 10°. Both sets are numbered. The names of the signs are written along the circle of the ecliptic. There is no label on the plate.

There is no label on the tablet of horizons either. Four sets of 7 half horizons of the latitudes from 12° to 66° are arranged in the four quadrants. The horizons are numbered at both the extremities.

12	20	28	36	44	52	60
14	22	30	38	46	54	62
16	24	32	40	48	56	64
18	26	34	42	50	58	66

Declination scales are drawn along the two diameters and numbered as 6, 12, 18, 23;30.

GEOGRAPHICAL GAZETTEER

On the inner side of the mater is engraved a geographical gazetteer in two concentric circular bands providing the names, longitudes and latitudes of 54 localities.[328] The two circles are separated by an empty circle which is bounded by double lines on both sides. In the outer circle, the letters are written upside-down, but in

[328] This astrolabe, smaller by 10 mm than the preceding two astrolabes, has a gazetteer of 54 places while A047 has a gazetteer of 46 places and A048 of 42 places.

the inner circle they are straight. The astrolabe being very small, it is at times difficult to read the latitudes of places engraved in tiny letters in the innermost circle.

Figure A048.3 – Geographical gazetteer (photo by Ahmad Athaullah)

Table A048-3 Geographical Gazetteer

	Place Name *Al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
	Outer Circle		
1	Miṣr	63;20	30;20
2	ᶜAdan	76;0	11;0
3	Madīnat Rasūl	75;20	25;0

	Place Name *Al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
4	Makkā Muᶜaẓẓam	77;10	21;40
5	Ṭā'īf	77;30	21;20
6	Bayt al-Maqdis	66;30	31;50
7	Dimashq	70;0	33;15
8	Ḥalab	72;10	35;50
9	Nakhajwān	81;15	38;40
10	Tabrīz	82;0	38;0
11	Kūfa	79;30	31;30
12	Baghdād	80.0	33;25
13	Baṣra	84;0	30;0
14	Shīrāz	88;0	29;36
15	Yazd	89;0	32;40
16	Hamadān	83;0	35;10
17	Qazwīn	85;0	36;0
18	Iṣfahān	86;40	32;25
19	Kāshān	86;0	34;0
20	Qumm	85;40	34;45
21	Rayy	86;20	35;0
22	Astarābād	89;35	36;50
23	Bisṭām	89;30	36;10
24	Sabzawār	91;30	36;5
25	Nīsābūr	92;30	36;21
26	Ṭūs	92;30	37;0
27	Harāt	94;20	34;30

	Place Name *Al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
28	Marw	97;0	37;40
29	Balkh	101;0	36;41
30	Badakhshān	104;24	37;10
31	Bukhārā	97;30	39;50
	Inner Circle		
32	Samarqand	99;36	39;37
33	Khujand	100;35	41;15
34	Kāshghar	106;30	44;0
35	Khutan	107;0	42;0
36	Hurmūz	92;0	25;0
37	Kābul	104;40	35;0
38	Kashmīr	108;0	35;0
39	Tubbat	110;0	40;0
40	Qandahār	107;40	33;0
41	Mūltān	107;35	29;40
42	Lahāwar	109;20	31;50
43	Haḍrat Dihlī	113;35	28;0
44	Akra	115;0	27;13
45	Qannawz	115;50	26;35
46	Kawāliyār	115;0	26;29
47	Bānārasī	117;20	26;55
48	Ujjayn	32;0 !	22;30
49	Burhānpūr	113;0	20;30
50	Aḥmadābād	108;40	23 (?);15

	Place Name *Al-bilād*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
51	Bījāpūr	108;30	17;20
52	Kolkanda	114;50	23;18
53	Sarāndīb	130;0	10;0
54	Kanbāyat	109;20	22;20

BACK

The rim of the two upper quadrants at the back carries the altitude scales divided in 1° and 6° and labelled as 6—90; 90—6. The rim of the lower half carries the cotangent scale, on the left for the base of 12 digits (labelled as *aṣābiᶜ*) and on the right for the base of 7 feet (labelled as *aqdām*).

The upper left is occupied by a trigonometric quadrant with 30 equidistant horizontal parallels. On the upper right, a solar quadrant with a circle of declination each for a pair of zodiac signs. The signs are labelled with their serial numbers along the two radii. Upon this grid are drawn two curves for the meridian altitude of the sun in all seasons for latitudes 27° and 32°, with the usual labels.

Figure A048.4 – Back of the astrolabe (photo by Ahmad Athaullah)

In the two lower quadrants, there are two shadow squares, on the left for the base of 12 digits and on the right for the base of 7 feet. The scales are divided, numbered and labelled in the usual manner.

The shadow squares are circumscribed by two concentric semi-circular scales; the outer one is inscribed with the names of the 12 zodiac signs and the inner one with those of the 28 lunar mansions.

Alidade

The straight bar alidade is plain without any graduations. The two ornate ends are tapered to a sharp point; the centre-piece is a plain circle. The sighting plates have two sighting holes each.

Inscription

Inside the shadow squares is the maker's signature in three lines:

aḍa^{c}*af al-*^{c}*ibād muḥammad muqīm ibn*
mullā ^{c}*īsā ibn shaykh allāhdād*
asṭurlābī humāyūnī lāhūrī.

'[Made by] the least of the servants [of God], Muḥammad Muqīm, son of Mullā ^{c}Īsā, son of Shaykh Allāhdād of Lahore, the astrolabe-maker of [the Emperor] Humāyūn.'

A049 ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED[329]

Diameter 90 mm

PLU, Ex-Skinner, Bolton, USA

Répertoire 33

Figure A049.1 – Front of the astrolabe (photo courtesy Professor David Pingree)

[329] This description is based on Linton 1980, no. 166, and the notes kindly provided by Professor David Pingree who described the astrolabe for the auction house Skinner; see also the Skinner 2002, p. 39.

A handy astrolabe with simple but elegantly designed *kursī* and rete. The lines of separation on the scales and many projected lines on the plates and on the back are dotted.

COMPONENTS

Body with *kursī* (d. 90), shackle and ring, rete, 5 plates, alidade, pin and horse.

FRONT

The ring is well-crafted; shackle with trifoliate shape and plain round bases. The *kursī* has lobed profiles and a trifoliate finial. It is pierced simply but elegantly, with 6 large perforations; two of these are shaped like bells or stylised tulips placed symmetrically on either side of the vertical line, three of the perforations are tear-shaped and the sixth one is triangular. Variations of this design can be seen in the retes of other astrolabes by Muqīm (A020, A021, A053).

The limb is divided in 1° and 6° and numbered in 6s from 6 to 90 in each quadrant separately.

RETE

The two broad rings of the Tropic of Capricorn and ecliptic are held together by a slender equinoctial bar which has counterchanges at the equinoxes. The inner edge of the Capricorn ring forms the circle of the Tropic of Capricorn. Therefore, a high triangular arch is attached to the ecliptic ring at the beginning of Capricorn, so that it functions as bridge up to the degree scale on the limb. The spaces between the rings is filled with a floriated tracery joining the star pointers. Inside the ecliptic ring, the tracery contains a heart-shaped motif in the middle. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names; each sign is further subdivided into five units and numbered as 6, 12, 18, 24, 30, separately for each sign. Further subdivisions, if there are any, cannot be seen in the available photos. There is a handle near star pointer of *Fam al-Qayṭus.*

David Pingree has counted some 29 star pointers. The starkly abridged names engraved on them in tiny script are difficult to decipher. The following are what he could read; here the names are rearranged according to the increasing right ascensions.

Table A049-1 Stars on the Rete

	Star Name	Identification
01	*Dhanab al-Qayṭus*	β Cetii
02	*Ṣadr Qayṭus*	π Ceti
03	*Ghūr* ! (*Rās al-Ghūl*)	β Persei
04	*Dabarān*	α Tauri
05	*Yad Jawjā' Yumnā*	α Orionis
06	*Shirᶜrā Yamānī*	α Canis Majoris
07	*Fard al-Shujāᶜ*	α Hydrae
08	*Qāᶜidat* [*al-Bāṭiya*]	α Crateris
09	*ᶜAnāq*	ξ Ursae Majoris
10	*Janaḥ al-Ghurāb*	γ Corvi
11	*Simāk ᶜAzal*	α Virginis
12	[*Simāk*] *Rāmiḥ* (?)	α Bootis
13	[*Nayyir al-*] *Fakka*	α Coronae Borealis
14	*ᶜUnuq Ḥayya*	α Serpentis
15	[*Rās al-*] *Jāthī*	α Herculis
16	[*Nasr*] *Wāqiᶜ* (?)	α Lyrrae
17	[*Nasr*] *Ṭā'ir*	α Aquilae
18	[*Minqār*] *al-Dajāja* (?)	β Cygni
19	*Al-Ridf*	α Cygni
20	*Dhanab al-Jady*	δ Capricorni
21	*Sāq Sāqib al-Mā' J[anūbī]*	δ Aquarii
22	*Mankib Faras*	β Pegasi
23	[*Kaff al-*] *Khaḍīb*	β Cassiopeiae

Plates

There are five plates, but there is some uncertainty about the latitudes for which they are engraved: 22° and 25°; 32° and 35°; 36° and 40°; 0° + 72° + 90° and 18° + 30° (?); tablet of ecliptic coordinates and tablet of horizons. It is surprising that there is no single plate for the latitudes of 27° and 32° on which the Agra and Lahore, the two Mughal imperial cities are situated and for which two solar meridian altitude graphs are plotted on the back. Azimuths are sometimes engraved below the horizon. There are lines for seasonal hours and for equal hours drawn from the western horizon.

The tablet of horizons carries four sets of half-horizons for the following latitudes:

4	14	24	34	44	54	64
6	16	26	36	46	56	66
8	18	28	38	48	58	
10	20	30	40	50	60	

Geographical Gazetteer

The geographical gazetteer is engraved in two concentric circles, providing the latitudes, names, longitudes of 42 places. The gazetteer commences in the inner circle. The places are arranged according to increasing longitudes.

Table A049-2 Geographical Gazetteer

	Place Name	L	φ
	Inner Circle		
01	Miṣr	63;70	30;20
02	Madīna	75;20	25;41
03	Makka	77;10	21;40
04	Bayt al-Maqdis	66;30	31;50
05	Dimashq	70;0	33;15
06	Tabrīz	87;0	38;0
07	Shīrāz	88;0	29;40
08	Qazwīn	85;0	36;0

	Place Name	L	φ
09	Iṣfahān	86;0	34;20
10	?	92;30	36;0
11	Harāt	?	37;30
12	Balkh	91;0	36;0
13	Bukhārā	94;35	39;50
14	Samarqand	99;16	39;37
15	Kāshghar	106;30	44;0
	Outer Circle		
16	Khutan	107;0	42;0
17	Hurmūz	92;0	26;0
18	Kābul	104;40	34;0
19	Kashmīr	108;0	35;0
20	Tubbat	105;0	40;0
21	Qandahār	102;40	33;0
22	Multān	107;35	29;40
23	Sālkūt	109;0	33;0
24	Lāhūr	109;20	31;50
25	Tānīsar	114;33	30;10
26	Bānībaht	113;20	28;52
27	Dihlī	113;35	28;39
28	Akbarābād	115;0	26;43
29	Kawālayār	111;0	26;29
30	Banāras	115;50	26;39
31	Qannawj	104;20	26;35

	Place Name	L	φ
32	Jawnbūr	119;6	26;36
33	Ajmīr	111;5	26;0
34	Ujjayn	100.50	23;30
35	Sarūj	72;40	34;50
36	Aḥmadābād	108;40	23;15
37	Burhānbūr	103;0	20;30
38	Dawlatābād	111;0	20;30
39	Bījābūr	105;30	17;20
40	Kūlkunda	114;19	18;20
41	Sarandīb	104;0	10;0
42	Kanbāyat	109;10	27;20

BACK

On the back dotted lines predominate: the vertical and horizontal diameters, alternate lines in the trigonometric quadrant, as also the boundaries between the cells in all the scales are marked by dotted lines. Likewise, the quarter circles in the upper right quadrant and the curves of the solar meridian altitudes are dotted.

The rim of the upper half contains the altitude scales divided in 1° and 6° and labelled in 6's as 6—90; 90—6.

In the upper left is the trigonometric quadrant with 20 horizontal and 20 vertical parallels.

The upper right quadrant is divided by 5 quarter circles into six segments, one for each pair of zodiac signs which are marked with their serial numbers along the two radii. Here are drawn two graphs of the solar meridian altitude for the latitudes of 27° and 32° with the labels *khaṭṭ zawāl bi-ᶜard 27* and *khaṭṭ zawāl bi-ᶜard 32* respectively.

Figure A049.2 – Back of the astrolabe (photo courtesy Professor David Pingree)

In the lower half are the shadow squares, on the left for the base of 12 and on the right for the base of 7. The scales are divided and numbered accordingly. The scales are accompanied by the following labels:

Vertical scale on the left: *ẓill sullam asabi*^{c} *ma*^{c}*kūs*

Horizontal scale on the left: *ẓill sullam asabi*^{c} *mustawī*

Horizontal scale on the right: *ẓill sullam aqadām mustawī*

Vertical scale on the right: *ẓill sullam aqadām ma^ckūs*

Within the shadow squares are two semi-circular rows containing the names of the 12 zodiac signs and those of the corresponding 28 lunar mansions respectively.

The rim on the lower half bears the scales of cotangents, marked on the left 6, 12, 18, 24, 30, 36, 47, 58, 60 *al-aṣābiᶜ* and on the right 6, 7, 12, 18, 22, 30, 41 (?), 55 (?) *al-aqdām.*

ALIDADE

Straight bar alidade with ornate tips and an ornate centre-piece, but without any graduations. Two holes in the sights. There is a pin and a wedge with a horse's head.

INSCRIPTION

In the space between the horizontal diameter and the semi-circular scales is engraved the astrolabe maker's signature, upside down:

> *ṣanᶜat muḥammad muqīm ibn ᶜīsā ibn allāhdād asṭurlābī humāyūnī lāhūrī*
>
> 'Made by Muḥammad Muqīm, son of ᶜĪsā, son of Allāhdād of Lahore, astrolabe maker to [the Emperor] Humāyūn.'

PROVENANCE

It appears to have come up for auction at Paris in 1978; subsequently in the private collection of Leonard Linton, Point Lookout, USA. Came up for auction at Nouveau Drouot, Paris, on 9 and 10 October 1980; again at Skinner, Bolton, USA in 2002.

BIBLIOGRAPHY

Alain Brieux, *Histoire des Sciences: Livres, Instruments, Machines*, Paris, Novembre 1978, no. 10517.

Linton 1980, no. 166, pp. 96-97.

Skinner 2002, p. 39.

A050 THE SMALLEST ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED

Diameter 45 mm

PLU, ex-Sotheby's, New York

Répertoire 36

Figure A050.1 – Front and back of the astrolabe (photo from Christie's catalogue of 24.9.92)

With a diameter of 45 mm, it is the smallest astrolabe made by Muqīm; in fact, it is the smallest known astrolabe in the world. Even so all the features of the Mughal astrolabes are meticulously incorporated in this astrolabe. Christie's catalogue remarks: 'This is one of the smallest recorded astrolabes, and a remarkable testimony to the skill of Muhammad Muqim of Lahore, being typical of his work, the engraving having been achieved with great accuracy.'

Components

Body with *kursī* (d. 45), shackle and ring, rete for 17 stars, 5 plates, alidade, pin and horse. The rete, alidade, pin and horse are not original.

Front

The ring is large and corrugated; the shackle is trifoliate. The *kursī* is worked *à jour,* incorporating the calligraphy *Allāh-u Akbar* inside the lobed frame, which terminates in a trifoliate finial. The limb, quite wide for its size, is divided in 2° and 6° and labelled in 6s from 6 to 90, separately for each quadrant, in clockwise direction. Dotted lines mark the boundaries of 6°.

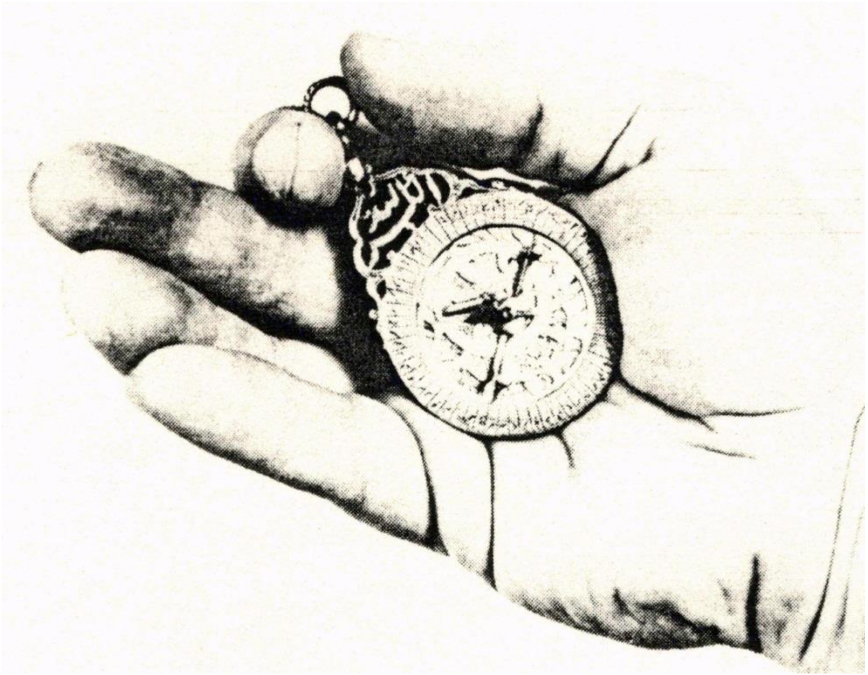

Figure A050.2 – The smallest astrolabe fits in the palm (photo from Saul Moskowitz catalogue 1990)

Rete

The rete is not original, but a late replacement. In the Sotheby's catalogue of 10 December 1981, where this astrolabe appears for the first time, the entry states 'lacking rete'; it does not appear in the illustration. In the catalogue of Saul Moskowitz of Spring 1990, where the astrolabe appears next, the rete is illustrated along with the alidade, pin and wedge, with the caption 'modern replacements'. Therefore, the rete must have been fabricated, not in India or Pakistan, but in the UK or US, between 1981 and 1990. Indeed, on the back of the rete is inscribed 'C.E. 1986'. Moskowitz catalogue states that it was 'made from a blank disc found with the instrument and engraved after an original rete from one of Muhammad Muqīm's larger astrolabes, suitably simplified for its reduced size (but still retaining its 18 stars).'

But the new rete does not resemble any rete in the known astrolabes made by Muqīm. With the arcs attached to the lower half of the Capricorn ring— the arcs from

which the star pointers arise—, this new rete resembles the rete in the astrolabe of ᶜĪsā dated 1604 (A006). The present rete has 17 or 18 star pointers, but it is difficult to decipher the names in the photos.

Plates

There are five plates serving the latitudes 27°, 32°; 36°, 0° + 90°; 40°, 18°+30°; tablet of ecliptic coordinates and tablet of horizons. A fifth plate with projections for latitudes 20°and 27° is less carefully engraved and is a late replacement.

From the small photos published in Christie's catalogue, it can be seen that in all latitude plates the altitude circles are for every 6° and labelled on both sides; azimuth arcs are drawn below the horizon for every 10° and labelled; there are lines for seasonal hours and sometimes also the lines for equal hours since sunset and before sunrise. At the centre are recorded the latitude (*ᶜarḍ*) for which the plate is calibrated and the duration of the longest day in hours (*sāᶜāt*). In other words, in this limited space are recorded all the features that are to be met with in larger astrolabes.

On the tablet of ecliptic coordinates is inscribed the label *ṣafīḥat mīzān al-ᶜankabūt,* while no such label is engraved on the tablet of horizons on the reverse.

Geographical Gazetteer

A geographical gazetteer of 34 places with their longitudes and latitudes is engraved inside the mater in two circles.

Back

The rim of the upper two quadrants bears the altitude scales, divided in 1°, 2°, 6° and labelled in 6° as 6—90; 90—6.

In the upper left is a trigonometric quadrant with 30 horizontal parallels, each third highlighted with dots. The upper right quadrant bears 5 declination arcs which divide the quadrant into 6 zones, each for a pair of zodiac signs which are marked by serial numbers along the two radii. Upon these are superimposed two graphs of solar meridian altitude for the latitudes of 27° and 32°. These are accompanied by the shorter labels *khaṭṭ zawāl bi-ᶜarḍ 27* and *khaṭṭ zawāl bi-ᶜarḍ 32* respectively.

Shadow squares are engraved in the lower half, on the left for the base 6/12 and on the right for the base 7. On the left the vertical and horizontal scales are divided in 6 parts, numbered from 1 to 6; then each division is halved to produce 12 divisions. On

the right the two scales are divided into 7 parts and numbered from 1 to 7. The labels are shortened here also. The vertical scale on the left is accompanied by the label *aṣābi*^{c} *ma*^{c}*kūs* (reverse [shadows in] feet) and the horizontal scale *aṣābi*^{c} *mustawī* (direct [shadows in] digits). Similarly, the horizontal scale on the right is labelled as *aqdām mustawī* (direct [shadows in] feet) and the vertical scale as *aqdām ma*^{c}*kūs* (reverse [shadows in] feet).

Circumscribing these squares are two semi-circular rows, the outer one inscribed with the names of the 12 zodiac signs and the inner one with the names of the 28 lunar mansions.

The rim of the lower half carries the cotangent scales. The scale on the left is marked with 6, 12, 18, 24, 30, 36, … 60, *aṣābi*^{c}*;* that on the right with 6, 7, 8, 12, 18, 24, 30, 30, 36, …, 60, *aqdām.* Each of these divisions are subdivided into 5 parts in the adjoining semi-circular row.

ALIDADE

The alidade is rather plain, with a circular centre piece and the ends shaped like quarter circles. The alidade is not graduated. The pin has a rather large circular head. The wedge is shaped like a horse's head.

INSCRIPTION (ACC. RÉPERTOIRE)

Inside the shadow squares is the inscription in three lines

aḍ^{c}*af al-*^{c}*ibād muḥammad*
muqīm ibn mullā ^{c}*īsā ibn*
shaykh Allāhdād

'[Made by] the weakest of the servants [of God], Muḥammad Muqīm, son of Mullā ^{c}Īsā, son of Shaykh Allāhdād.'

PROVENANCE

Although it is one of the most precious creations of the Lahore family, it changed hands rather frequently. It came up for auction, for the first time, at Sotheby's in December 1981 without the rete. Then in spring 1990, it made its appearance equipped with a rete, in the catalogue of Saul Moskowitz. Two years later it came up for auction at Christies in September 1992. It came up again for auction at Sotheby's, New York, in September 2001. Its present location is unknown.

BIBLIOGRAPHY

Sotheby's catalogue, 10 December 1981, lot 23, p. 11.

Saul Moskowitz catalogue 133, Spring 1990, lot 155, p. 37.[330]

Christie's catalogue of 24 September 1992, lot 116, pp. 44-45.

Sotheby's, New York, auction catalogue 21 September 2001, lot 147.

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330 The astrolabe appears to have been included also in an earlier catalogue of Saul Moskowitz with practically the same text, but I do not have the number of the catalogue.

A051⊙ ZOOMORPHIC ASTROLABE ATTRIBUTABLE TO MUḤAMMAD MUQĪM, NOT DATED[331]

Diameter 344 mm

Jaipur, Jai Singh's Observatory

CCA74

Figure A051.1 – Front of the astrolabe (photo by S. R. Sarma)

331 I had the privilege of accompanying Professor David King when he examined this astrolabe in 1991. This description is partly based on his notes. I copied the gazetteer on a subsequent visit.

This fabulous Mughal astrolabe with a zoomorphic rete and several other equally splendid Lahore astrolabes were collected by the astronomer-prince Sawai Jai Singh in the first quarter of the eighteenth century and were in his personal collection at Jaipur. This and the two other astrolabes made by Ḍiyā’ al-Dīn Muḥmmad (A072 and A091) formed the basis for G. R. Kaye’s pioneering discussion of the construction and use of the astrolabe in his book *The Astronomical Observatories of Jai Singh.*[332]

R. T. Gunther, the celebrated author of the *Astrolabes of the World*, was so impressed by this astrolabe that he wrote: ‘The ankabut presents what is perhaps the finest example of tracery known to us, comprising foliations and star-animals most artfully disposed along the course of stems and tendrils that branch but never cross.’[333] He even embellished the cover of his book with an outline of the *kursī* and the rete printed in gold. Likewise Owen Gingerich is effusive in his appreciation of this astrolabe: ‘A much later Indian astrolabe from around 1650, the so-called Jaipur A instrument, shows many playful elements, almost resembling a child’s puzzle in the subtle and intricate way in which the animals have been incorporated into the tracery. Not only Vega and Alatair shown as birds, but Deneb (of Cygnus as well). Procyon and Sirius appear as dog’s heads, possibly uniquely in the Islamic world. There is also a bull, a horse, and a river, and probably a whale and a bear among several other figures awaiting decipherment!’[334]

The astrolabe is not signed, but the 29 zoomorphic star pointers in the rete correspond exactly to those in the astrolabe made by Muḥammad Muqīm in 1637 which is now with the Salar Jung Museum of Hyderabad (A026). Therefore, this astrolabe can safely be attributed to Muqīm.

It is much larger than the signed astrolabe at Hyderabad and is filled with very fine engravings. In the upper right quadrant on the back, quarter circles are drawn for each 2° of the solar longitude. These circles fill the entire surface, leaving just 1 mm wide space in between. Likewise, on all the latitude plates, altitude circles are drawn for each

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332 Kaye 1918, pp. 16-36.

333 Gunther 1932, p. 204.

334 Gingerich 1987a, pp. 96, 102.

1°. On plates 1b and 5b lines are drawn for 1/6 part of a *ghaṭī* (= 4 minutes). Here also the space between lines is not wider than 1 mm.

Components

Body with *kursī* (d. 344, h. 427, t. 19), shackle and ring, rete for 42 stars, 7 plates, alidade, elegant pin, washer and horse.

Front

Massive shackle and ring, both with diamond cross section. The shackle is trifoliate and its bases are circular. The *kursī* has a trifoliate finial and finely cut fretwork with a cartouche in the middle.

The degree scale on the rim is divided in 3°, 1° and 0;15° in three concentric bands. In the outer band, groups of 3° are numbered clockwise from 3° to 360°. On the edge there is a long inscription, possibly a Persian poem, the letters are in relief against a hatched background, like the names of the zodiac signs on the ecliptic ring.

Figure A051.2 – Rete of the astrolabe (photo by S. R. Sarma)

RETE

The two rings of the Tropic of Capricorn and the ecliptic are held together by the equinoctial bar which is counter-changed at the two points where it intersects the ecliptic. The upper edge of the middle segment of the bar represents the equinoctial colure. The ecliptic circle is divided into the 12 signs and labelled with their names which stand out in relief against a chased background. Each sign is divided into units of 3° and numbered as 3, 6, 9, …. 24, 27, 30. The sloped edge of the ecliptic circle is divided in 1°.

There are 42 named star pointers. Of these 29 are given zoomorphic or anthropomorphic forms as in the Hyderabad astrolabe with the same iconography. The star pointers are joined by a very delicate tracery of tendrils with stylized leaves and small flowers with four or five petals as in the openwork design of the *kursī.*

Table A051-1 Stars on the Rete

	Star Name	Identification	Symbolic Representation
1	*Dhanab al-Qayṭus J[anūbī]*	β Ceti	fin of the fish tail
2	*Baṭn al-Ḥūt*	β Andromedae	
3	*Fam al-Qayṭus*	γ Ceti	snarling dog's head
4	*Ṣadr al-Qayṭus*	π Ceti	
5	*Kaff al-Jadhmā'*	α Ceti	
6	*Rās al-Ghūl*	β Persei	demon's head with horns
7	*Tālī Masāfat al-Nahr*	γ Eridani	river with waves
8	*ᶜAyn al-Thawr*	α Tauri	bull's head with horns
9	*ᶜAyyūq*	α Aurigae	
10	*Rijl al-Jawjā' al-Yusrā*	β Orionis	shoe
11	*Yad al-Jawjā' al-Yusrā*	γ Orionis	hand
12	*Yad al-Jawjā' al-Yumnā*	α Orionis	hand
13	*Rijl al-Jawjā' al-Yumnā*	κ Orionis	shoe
14	*Shiᶜrā*	α Canis Majoris	dog's head
15	*Shiᶜrā*	α Canis Minoris	dog's head
16	*Minkhar al-Shujāᶜ*	σ Hydrae	snake's head
17	*Fard al-Shujāᶜ*	α Hydrae	
18	*Qalb al-Asad*	α Leonis	
19	*Rās al-Asad*	μ Leo	lion's head
20	*Ẓahr al-Dubb al-Akbar*	α Ursae Majoris	bear's back

	Star Name	Identification	Symbolic Representation
21	*Qāᶜidat al-Bāṭiya*	α Crateris	bucket
22	*Ẓahr al-Asad*	δ Leonis	
23	*Janāḥ al-Ghurāb*	γ Corvi	wing
24	*Simāk Aᶜzal*	α Virginis	Virgo’s hand
25	*Al-ᶜAnāq*	ζ Ursae Majoris	
26	*Simāk-i Rāmiḥ*	α Bootis	
27	*Nayyir al-Fakka*	α Coronae Borealis	crown, more like a cup
28	*ᶜUnuq al-Ḥayya*	α Serpentis	snake’s head
29	*Rās al-Jāthī*	α Herculis	human face
30	*Rās al-Ḥawwā’*	α Ophiuchi	human face
31	*Nasr Wāqiᶜ*	α Lyrae	bird’s head
32	*Minqār al-Dajāja*	β Cygni	chicken
33	*Nasr al-Ṭā’ir*	α Aquilae	bird’s head and neck
34	*Dhanab al-Dajāja*	α Cygni	
35	*Dhanab al-Jady*	δ Capricorni	tail
36	*Fam al-Faras*	ε Pegasi	
37	*Sāq Sākib al-Mā’ J[anūbiya]*	δ Aquarii	
38	*Mankib al-Faras*	β Pegasi	horse’s head and shoulder
39	*Surrat al-Faras*	α Andromedae	Andromeda’s face
40	*Janāḥ al-Faras*	γ Pegasi	tip of a wing
41	*Dhanab al-Qaytus Sh[amālī]*	ι Ceti	fin of the fish tail
42	*Kaff al-Khaḍīb*	β Cassiopeiae	

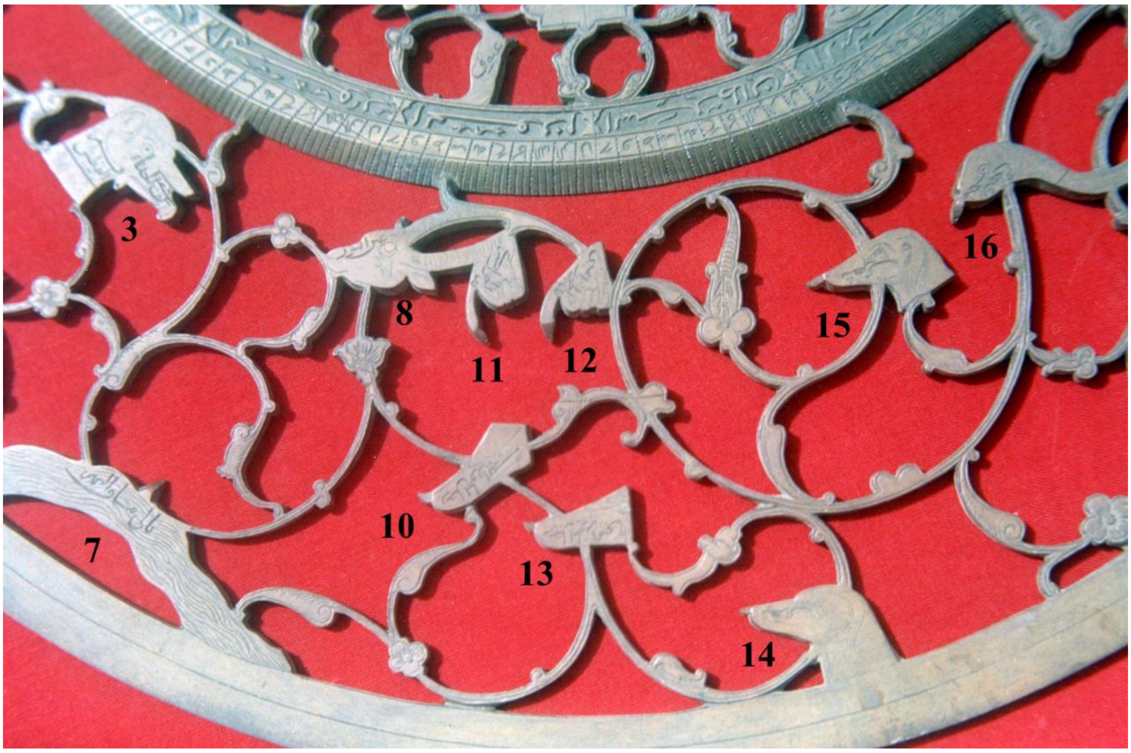

Figure A051.3 – Detail of Figure A051.2, showing (from left to right) the star pointers γ Ceti (3), γ Eridani (7), α Tauri (8), β Orionis (10), γ Orionis (11), α Orionis (12), κ Orionis (13), α Canis Majoris (14), α Canis Minoris (15) and σ Hydrae (16). At the top can be seen a section of the ecliptic ring with the embossed names of zodiac signs al-Thawr, al-Jawzā' and al-Saraṭān.

PLATES

There are seven plates with the following specifications:

Table A051-2 Plates

	φ	Longest day *hours* *ghaṭīs*	Additional lines for *ghaṭīs*	Locality for which the plate is designed
1a	16;20,16°	12;59	*ghaṭī* lines	Golconda?
2a	18°	18;05[335]		Bijapur
3a	21°	13;21		Mecca
3b	23;30°	13;24		Ujjain/Tropic of Cancer
2b	25°	13;25		Medina

[335] Clearly a mistake for 13;5 hours.

4a	27°	13;48[336]	*karhī* 34;25	*ghaṭī* lines	Agra
1b	28;39,20°	13;50		1/6 *ghaṭī* lines	Delhi
5a	30°	13;58		*ghaṭī* lines	
4b	32°	14;08	*karhā* 35;20	*ghaṭī* lines	Lahore
5b	35°	14;19	*karhā* 35;48	1/6 *ghaṭī* lines	
6a	36°	14;28			
6b	40°	14;52			
7a	Tablet of ecliptic coordinates				
7b	Tablet of horizons				

On the first six plates meant for different latitudes, the altitude circles are drawn for every 1° and each fifth line is highlighted by dotted lines. Azimuth arcs are drawn for every 5°, sometimes below the horizon and some other times both above and below the horizon.

There is much variation in hour lines; besides the lines of seasonal hours and equal hours since sunset and before sunrise, there are lines for (equal) *ghaṭīs* on some plates, viz. 1a (16;20,16°), 4a (27°), 4b (32°) and 5a (30°). On 1b (28;39,20°) and 5b (35°) there are lines for still finer time units, viz., 1/6 *ghaṭīs* (= 4 minutes). It must have been a stupendous task to draw these dotted lines for 1/6 *ghaṭī,* leaving very little space between every two lines (see Figure A051.8). While the lower half is thus filled with densely packed lines in just two plates, the upper half of all plates is filled in the same manner with altitude circles drawn for every 1° (see Figure A051.4).

On each of these, the latitude (*al-ᶜarḍ*) for which it is designed is mentioned as also the maximum duration of the daylight at this latitude in hours (*al-sāᶜāt*). On the three plates (4a for 27°, 4b for 32° and 5b for 35°), the maximum duration is also mentioned in *ghaṭīs* (spelt *karhī* or *karhā,* the latter apparently plural). One would have

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336 13;48 hours translate to 34;30 *ghaṭīs.* In Muqīm's astrolabes the usual value at latitude 27° is 13;43 or 13;46 hrs. The latter equals to 34;25 *ghaṭīs* which is engraved on the plate.

expected that this done consistently on all plates which carry *ghaṭī* lines, but this is not done on plates 1a, 1b, and 5a.

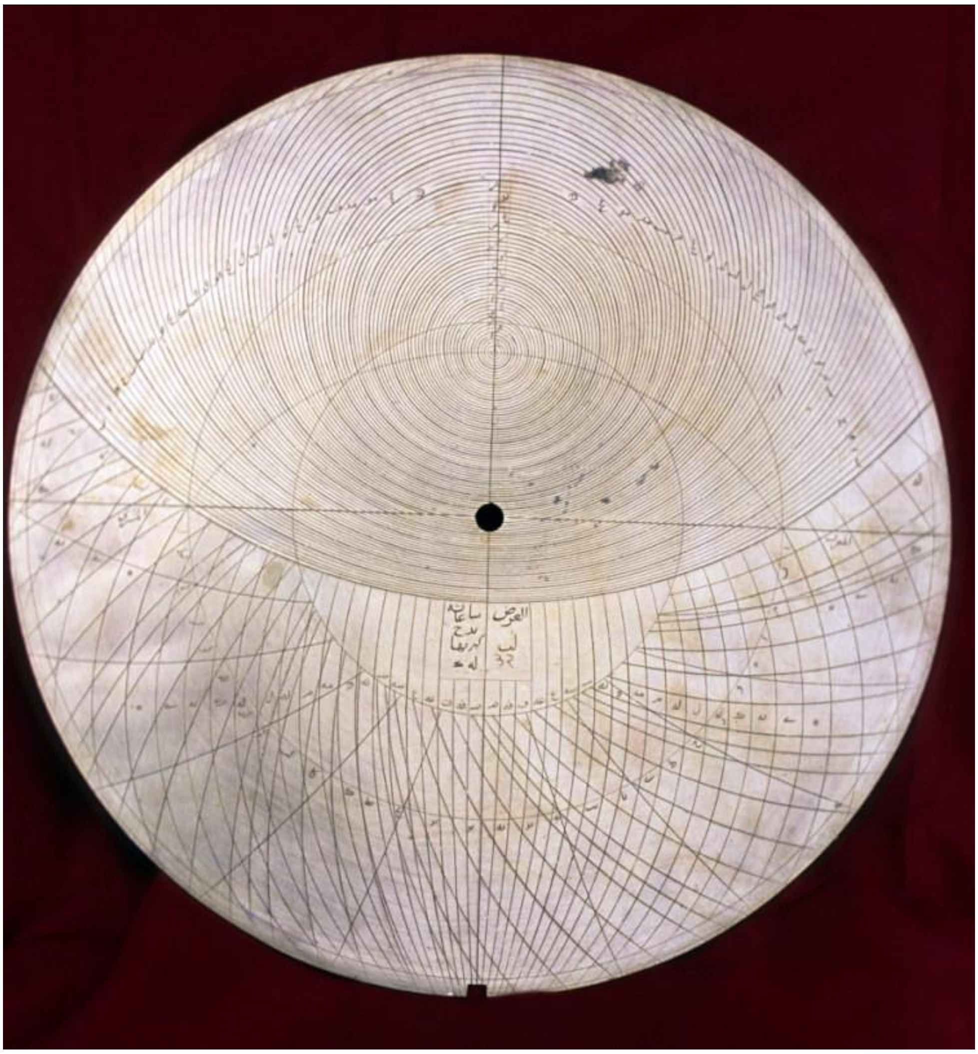

Figure A051.4 – Plate 4b drawn for the latitude of Lahore at 32° with lines for seasonal hours, equal hours and *ghaṭīs,* the last two counted from the western horizon (photo by S. R. Sarma)

Plate 7a is engraved as the Tablet of ecliptic coordinates with altitude circles for each 1° and longitude circles for each 6°. The names of zodiac signs are engraved along the ecliptic circle together with the subdivisions. On the reverse side of this plate is the tablet of horizons with four sets of half-horizons for latitudes

4	8	12	…	64
5	9	13	…	65
6	10	14	…	66
7	11	15	…	67

In addition, there are three full circles of horizons for higher latitudes which are not mentioned but presumably for 72°. The declination scales are divided in 1° and labelled in 3° up to 23;30°.

GEOGRAPHICAL GAZETTEER

On the inner side of the mater is engraved a very large geographical gazetteer with the longitudes, names and latitudes (in this order) of 235 places in five concentric circles. Although the gazetteer is engraved with the enormous number of 1700 entries, it does not look cluttered because of the judicial use of the empty spaces between the five circles. Moreover, variety is introduced in each circle.

Figure A051.5 – Geographical gazetteer (photo by S. R. Sarma)

Each unit comprising the longitude, place name and latitude engraved one below the other is separated from the next by a pair of lines, the style of which varies from circle to circle. In the first circle the lines of separation are zigzag lines and every tenth pair of lines (i.e. after 10 towns) is highlighted with dots; in the second circle, the lines of separation are also jig-jag lines (but facing the opposite direction) and here every eighth pair is highlighted with dots; in the third circle the lines of separation are straight lines and here every sixth pair is highlighted; in the fourth circle the lines of separation are curved to the right and every fourth pair is highlighted; finally in the fifth circle the lines of separation are curved to the left and here every second pair is dotted. Since each succeeding circle is smaller than the previous one, the dotted lines of separation in successive circles are in alignment and can be seen as radiating from the centre.

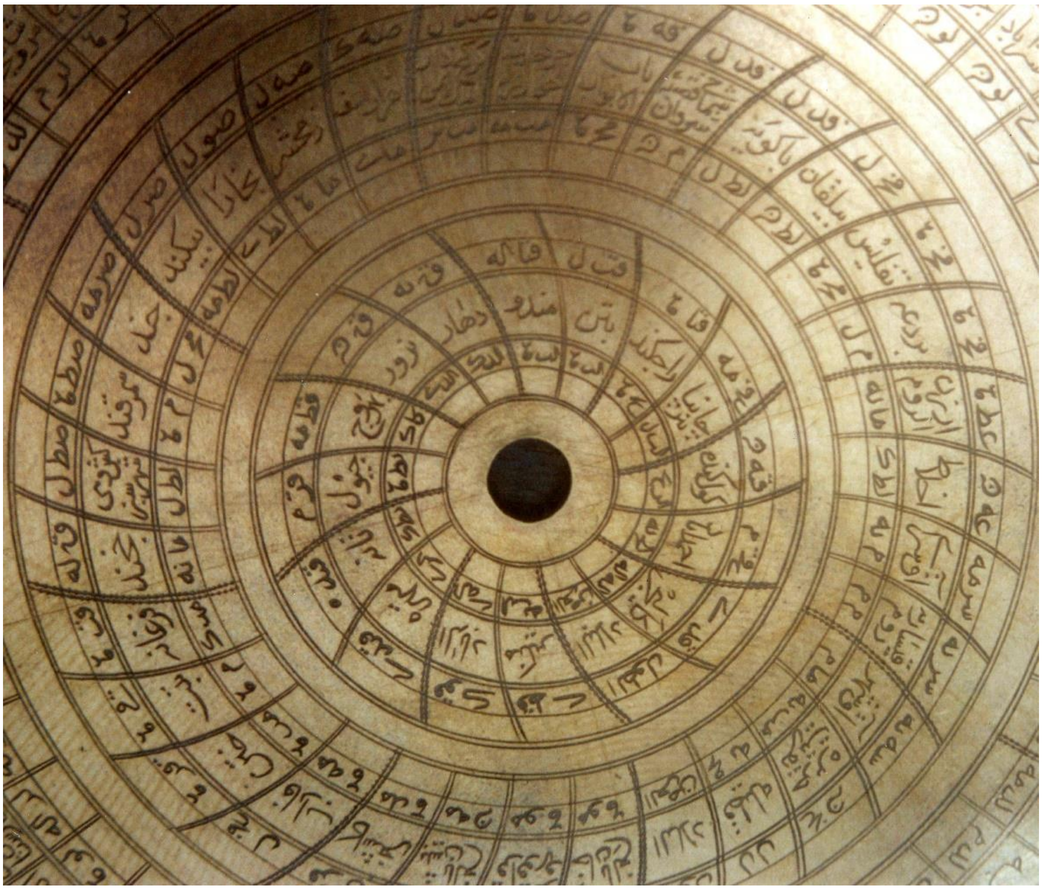

Figure A051.6 – Detail of Figure A051.5

In each circle, the first cell (to the left of the vertical radius) is occupied by the argument. From then on the gazetteer proceeds leftwards.

The places are arranged roughly according to increasing latitudes, starting with the coast of the mythical Oceanus on latitude 0° and going up to Khān Bāligh (modern Beijing) on 46° in the fourth circle. Several cities of the Indian subcontinent are already

mentioned in the first and second circles. Some other Indian cities are enumerated in the fifth circle, as a kind of addendum.

Table A051-3 Geographical Gazetteer

	Place Name	L	φ
	First Circle		
1	Sāḥil Baḥr Awqiyānūs	11;0	0;0
2	Jarmī dār al-Mulk Ḥabasha	65;0	9;30
3	ᶜAdan	76;0	11;00
4	Barbar az Bilād Zanj	78;0	6;30
5	Jazīrat Sarāndīb	130;0	10;0
6	Jamkūt	176;0	5;0
7	Kankdaz	180;0	0;0
8	Dhabīd	74;20	14;10
9	Jabal	75;0	13;30
10	Ṣanaᶜā’ Dār al-Mulk Yaman	77;0	14;30
11	Ẓafār	77;35	13;20
12	ᶜAmmān Sahār Qaṣba	84;15	19;20
13	Zaytūn	154;0	17;15
14	Bījābūr	105;30	17;20
15	Sūs al-Aqṣa Maghrib	15;30	24;0
16	Qatīf	74;0	25;0
17	Jᶜana	74;0	21;0

	Place Name	L	φ
18	Madīnat Rasūl ᶜAlayhi al-Salām	75;0	25;0
19	Khaybar	75;20	24;20
20	Jadda	76;00	21;0
21	Makka Muᶜaẓẓam	77;10	21;40
22	Tā’īf	77;30	21;20
23	Ḥajar Baḥrayn	83;15	25;15
24	Jazīrah Sarāb	88;30	25;0
25	Hurmūz	92;0	24;0
26	Jīruft	93;0	26;30
27	Tīz Qaṣba Makrān	103;0	24;15
28	Mansūra	105;0	26;40
29	Ṣanam Sawmnāt	107;10	22;15
30	Kanbāyat	109;20	22;20
31	Qannawj	104;50	26;15
32	Banāras	116;20	26;15
33	Dawlatābād	101;0	20;30
34	Kawālīyīr	104;0	26;29
35	Lakhnawtī	105;53	26;30
36	Kopāmayū	116;33	26;45
37	Jawnbūr	119;6	26;36
38	Karah wa Mānikbūr	118;10	26;49

	Place Name	L	φ
39	Ajmīr	112;5	26;0
40	Awadh	118;6	27:22
41	Akbarābād Dar al-Khalāfat	115;4	26;43
42	Burhānpūr	113;0	20;30
43	Asfī	12;15	30;15
44	Ṭāhart ᶜAlyā	35;32	31;45
45	Qayrawān	41;15	31;15
46	Mahdiyya	42;15	32;30
47	Ṭārābulus Maghrib	45;15	32;30
48	Iskandariyya	61;55	30;58
49	Miṣr	63;0	30;20
50	Dumayāt	63;12	31;35
51	Qulzum az Kanār Darya	64;15	28;30
52	Bayt al-Maqdis	66;30	31;50
53	Qaysāriyya Shām	66;30	32;50
54	ᶜAmmān	67;20	31;0
55	Ṭabariyya	68;15	32;0
56	Baᶜalbāk	70;45	33;15
57	Dimashq	70;0	33;20
58	Ḥilla	79;15	32;15
59	Kūfa	79;30	31;30
60	Baghdād	80;15	33;20

	Place Name	L	φ
61	Madā'īn	80;20	33;0
62	Nuᶜmāniyya	80;20	33;15
63	Wāsit	81;30	32;20
64	Ḥulwān	80;55	34;0
65	Baṣra	84;0	30;0
66	Ahwāz	84;0	31;0
67	Tustar	84;30	31;30
68	Ḥaṣn Mahdī	84;15	30;15
69	Rāmhurmūz	85;45	31;0
70	Iṣfahān	86;3	32;15
71	Kādhirūn	47;0	29;15
72	Nawbandkān	47;15	30;10
73	Abarquh	77;20	31;30
74	Fīrūzābād	77;30	28;10
75	Shīrāz	48;0	29;30
76	Iṣṭakhr	88;30	30;0
77	Yazd	89;0	32;0
78	Dārābjird	90;15	28;15
79	Sirjān	90;20	29;30
	Second Circle		
80	Kirmān	91;30	30;0
81	Ṭabas Gilakī	92;0	33;0
82	Zarand	92;15	30;15
83	Bardshīr	92;30	30;15

	Place Name	L	φ
84	Khabīṣ	93;0	31;15
85	Bam	94;0	28;30
86	Ṭabas Sinā	94;19	33;15
87	Zaranj az Sijistān	97;40	32;30
88	Kīj az Makrān	99;0	28;30
89	Bust	100;0	33;0
90	Maymand	101;55	33;20
91	Ghazna az Zābulistān	104;20	33;25
92	Ribaṭ Amīr	105;0	24;0
93	Multān	106;25	29;40
94	Qandahār	107;40	33;0
95	Nahlawāra	108;20	28;40
96	Parshūr	105;55	31;0
97	Lāhūr	109;20	31;50
98	Dihlī	113;35	28;39
99	Farmal	104;35	32;55
100	Sālkūt	109;0	33;0
101	Hānsī	112;25	29;45
102	Sunām	112;25	30;30
103	Tānīsar	112;33	30;10
104	Pānīpat	113;20	28;52
105	Baran	114;0	28;48
106	Kol-Jalālī	114;19	28;4

	Place Name	L	φ
107	Badāūan	114;59	27;32
108	Sulṭānkūt	115;0	28;30
109	Samīr	105;40	32;15
110	Bajāv Qayānūs Ṭanharirdīn?	70;15	35;0
111	Jazīrah Aqrīṭis wa Madīhnā	55;40	36;30
112	Jayrūn	67;30	35;15
113	Ṭarsūs	68;40	36;50
114	Ṭarābulus Shām	69;40	35;15
115	Ḥimṣ	70;45	34;0
116	Ḥalab	72;10	35;50
117	Mārdīn	74;15	37;50
118	Jazīra ibn ᶜUmar	75;30	34;30
119	Bukhār ?	76;0	36;0
120	ᶜĀna	76;30	34;0
121	Mawṣil	77;0	36;50
122	Arjīs	77;0	38;30
123	Niṣībīn	75;20	37;40
124	Afdar	77;20	36;52
125	Nawshahr	78;20	38;10
126	Nakadīt	73;25	34;0
127	Sāmrā	79;15	34;15
128	Salmās	79;15	37;40

	Place Name	L	φ
129	Ūrmiya	79;45	37;0
130	Daybul	80;30	38;0
131	Tajwān	81;15	37;45
132	Qaṣr Shīrīn	81;40	33;45
133	Marāqha	80;0	36;20
134	Tabrīz	82;0	38;0
135	Ardabīl	82;20	37;20
136	Miyāna	82;30	36;0
137	Hamadān	83;0	35;10
138	Zanjān	83;0	36;30
139	Suhraward	83;0	36;0
140	Nahāwand	83;0	34;20
141	Abhar	84;30	36;45
142	Karaj	84;45	34;0
	Third Circle		
143	Sāwa	85;0	36;15
144	Qazwīn	85;0	36;15
145	Sulṭāniyya	85;0	36;30
146	Abah	85;10	34;40
147	Qūm	85;40	34;45
148	Jurbādaqān	85;35	34;15
149	Kāshān	86;0	34;0
150	Rayy	86;20	35;0
151	Khuwār	87;10	35;40

	Place Name	L	φ
152	Amul	87;20	36;0
153	Dāmghān	88;0	37;20
154	Samnān	87;20	36;40
155	Sāriya	88;0	37;0
156	Busṭām	89;30	36;10
157	Astarābād	89;30	36;50
158	Jurjān	90;0	36;50
159	Farāwa	90;0	39;0
160	Sabzawār	91;30	36;0
161	Isfarāīn	91;40	37;55
162	Turshīz	92;0	35;0
163	Nīshābūr	92;30	36;21
164	Mashhad	92;30	36;0
165	Tūn	92;30	34;30
166	Nūqān	92;45	38;40
167	Qā'īn	93;20	36;30
168	Zūzan	93;30	35;19
169	Jūrjān	92;0	37;0
170	Marv Shāhijān	94;0	37;40
171	Harāt	94;20	34;30
172	Sarakhs	94;30	36;0
173	Bādghīs	94;30	35;20
174	Marv Rūd	94;40	34;30
175	Būshank	95;40	37;50

	Place Name	L	φ	
176	Ṭāliqān Khurāsān	98;15	37;30	
177	Fāriyāb	99;0	36;45	
178	Balkh	101;0	36;41	
179	Samanjān	102;15	37;15	
180	Ṭāliqān Ṭukhāristān	102;50	37;25	
181	Andarāb	103;45	36;0	
182	Badakhshān	104;25	36;10	
183	Kābul	104;40	34;30	
184	Kābul ᶜAhrāz	104;40	35;0	
185	Kashmīr	105;0	35;0	
186	Bulūr	103;0	36;0	
187	Ashnūna	17;15	42;40	Lisbon
188	Wasit Jazūrah Fārs	18;14	39;5	
189	Madīnat Salām	28;15	43;15	Medinaceli, Spain
	Fourth Circle			
190	Taṭīla	30;30	43;15	
191	Jazīrah Niqarnīt	58;50	42;15	
192	Āqshahr	65;15	41;40	
193	Qaysāriyya Rūm	67;15	40;40	
194	Āqsarāy	67;45	40;15	
195	Akhlāt	75;50	39;20	

	Place Name	L	φ
196	Arzan al-Rūm	79;0	41;15
197	Bardaᶜa	83;0	40;30
198	Tiflīs	83;0	43;0
199	Baylaqān	83;30	39;50
200	Bākūya	84;30	39;30
201	Sharwān Shamā Faṣadī?	84;30	40;50
202	Bāb al-Abwāb	85;0	43;0
203	Khwārizm Jurjāniya	94;0	42;44
204	Almāk Yaman Karīzdhād	94;30	42;17
205	Hazār Asf	95;20	41;10
206	Zamakhshar	95;30	41;0
207	Bukhārā	96;30	39;10
208	Baykand	97;30	39;45
209	Jind	97;45	43;30
210	Samarqand	99;0	40;0
211	Shahar Shabz Kish Rūmī	99;30	39;30
212	Khujand	100;15	41;55
213	Farghānā	102;0	42;20
214	Tubbat	110;0	40;0
215	Khutan	104;0	42;0
216	Fārāb	88;30	45;0
217	Kāshghar	107;30	44;0

	Place Name	L	φ	
218	Bashīn Bāligh	102;0	45;50	
219	Qarāqūrūm	105;0	46;0	
220	Khān Bāligh	124;0	46;0	
	Fifth Circle			
221	Kālanjar	104;10	25;25	
222	Aḥmadābād	108;40	28;15	
223	Kolkanda	105;50	24;18!	
224	Chānpānīr	108;45	22;30	
225	Rājkand	102;0	18;0	
226	Batn	102;30	24;0	
227	Mandū	102;25	22;0	
228	Dhār	100;15	24;20	
229	Narwar	100;50	24;10	
230	Bahrūj	109;45	21;20	
231	Juyūl	107;40	19;0	
232	Tāna	114;5	19;20	Thane
233	Mathrah	114;10	27;10	Mathura
234	Ilāhbād	106;20	25;10	
235	Mankīr	109;10	22;15	

BACK

The rim of the two upper quadrants bears the altitude scales, divided in 0;30°, 1° and 3° and labelled as 3—90; 90—3.

In the upper left is a sexagesimal trigonometric quadrant with 60 horizontal and 60 vertical parallels with each third line highlighted. There is a semicircle on the

horizontal radius and quarter circles with radii at 24 (obliquity) and 30 units; the latter is unusual.

The upper right quadrant is engraved as the solar quadrant with declination circles for each 2°of the longitude of the sun, with every third circle highlighted with dots. The corresponding signs are labelled along the two radii and groups of 6° are numbered separately for each sign. Two sigmoid curves are drawn to show the meridian altitudes of the sun throughout the year for the latitudes of 27° and 32°. Along these curves are inscribed the labels *khaṭṭ niṣf al-nahār bi- ᶜarḍ 27* (line of the midday altitude at the latitude of 27°) and *khaṭṭ niṣf al-nahār bi- ᶜarḍ 32* (line of the midday altitude at the latitude of 32°).

In the lower half are the two shadow squares. On the left is the shadow square for the base of 12 and 60. Here the vertical and horizontal scales are divided into 12 parts each and numbered accordingly. Each part is further subdivided into 5 units and numbered in 5s from 5 to 60. The horizontal scale is accompanied by the label *ẓill sullam aṣābiᶜ mustawī* and the vertical scale by the label *ẓill sullam aṣābiᶜ maᶜkūs.* These labels are inscribed inside the shadow squares.

Outside the shadow squares, there are additional labels for the sexagesimal scale; under the horizontal is engraved *ẓill sattaynī mustawī* and to the left of the vertical scale *ẓill sattaynī maᶜkūs.*

On the right is the shadow square for the base of 7. Here the vertical and horizontal scales are divided into 7 parts each and numbered accordingly. The horizontal scale is accompanied by the label *ẓill sullam aqdām mustawī* and the vertical scale by *ẓill sullam aqadām maᶜkūs.*

Figure A051.7 – Back of the astrolabe (photo by S. R. Sarma)

The lower half of the rim is engraved with the cotangent scales in two semi-circular rows. The unequal divisions in the scale on the left are numbered in 3s from 3 to 60, followed by the label *ẓill aṣābi*[c]. Those in the scale on the right are likewise

numbered in 3s from 3 to 60, followed by the label *ẓill aqdām.* The scale that follows is divided in single units.

Inside the cotangent scales are three semi-circular rows containing a table of limits of the signs (*ḥudūd*). In the first row are engraved the names of the signs in full. In the second row, the names of the planets (five for each planet) are inscribed with the last letters of their names and in the third row the strengths of each of the five planets in *abjad* notation.

Within the shadow squares, there are four concentric semi-circular rows. The outermost row carries the names of the 28 lunar mansions, while the next is filled with the names of the 12 corresponding zodiac signs. In the next two rows are mentioned the regents and the decans respectively.

Besides these two semi-circular tables, there are three rectangular tables. Below the shadow squares is a table with the title *mabādi'-yi aqālīm-i sabᶜa* (beginnings of the seven climates) in four rows and eight columns.[337] It displays the latitudes (*al-ᶜarūḍ*) and the hours of the maximum daylight (*al-sāᶜāt*) at the beginning (*mabdā'*) and the middle (*wasaṭ*) of the seven climates (*aqālīm*).

Table A051-4 Climates

aqālīm	***mabādī wa awāsiṭ***	***al-ᶜarūḍ***	***al-sāᶜāt***
Al-Awwal	*mabdā'*	12;43	12;45
	wasaṭ	16;44	13;0
Al-Thānī	*mabdā'*	20;31	13;15
	wasaṭ	24;10	13;30
Al-Thālith	*mabdā'*	27;34	13;45
	wasaṭ	30;46	14;0
Al-Rābiᶜ	*mabdā'*	33;43	14;45
	wasaṭ	36;28	14;30
Al-Khāmis	*mabdā'*	39;1	14;45

337 Cf. Kaye 1918, p. 132.

aqālīm	***mabādī wa awāsiṭ***	***al-ᶜarūḍ***	***al-sāᶜāt***
	wasaṭ	41;21	15;0
Al-Sādis	*mabdā’*	43;30	15;15
	wasaṭ	45;39	15;30
Al-Sābiᶜ	*mabdā’*	47;38	15;45
	wasaṭ	48;59	16;0

To the left of the shadow squares is a table with the heading *faḍl al-dawr* (excess of revolution) in 9 x 4 cells, providing the multiples of the difference between the length of the tropical year and 365 days.

To the right of the shadow squares is another rectangular table entitled *arbāb muthallathāt lāylī wa nahārī* (the regents of the triplicities, nocturnal and diurnal). The triplicities and the regents are enumerated in four sub-tables according to their nature: *nārī* (fiery), *tarābī* (earthy), *hawā’ī* (airy) and *hāmī* (watery).

ALIDADE, PIN, HORSE

The alidade is rectilinear with pierced clef ends and a trifoliate centerpiece. It bears an ecliptic scale on the right with the names of the signs inscribed in full in two rows and a sexagesimal scale and a universal hour scale on the left. There is a small quatrefoil on the top of the decorated button on the pin and an eight-petalled flower shaped washer. The wedge is horse-shaped.

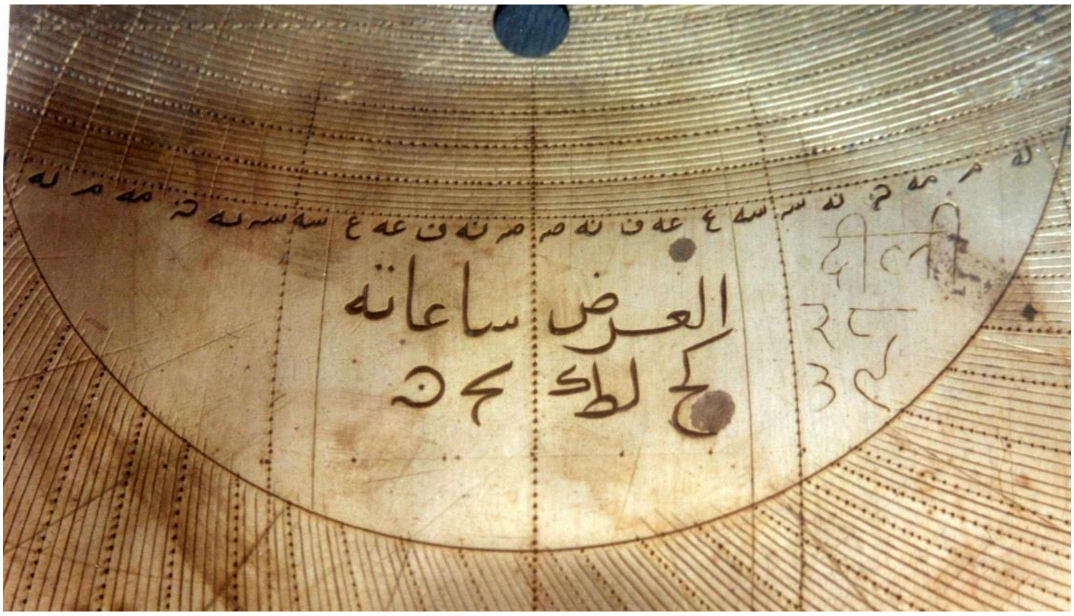

Figure A051.8 – Plate 3b with Devanagari additions

PROVENANCE AND ADDITIONAL MARKINGS IN DEVANAGARI

In the early eighteenth century, Sawai Jai Singh acquired this astrolabe along with some other outstanding astrolabes of the Lahore family. Apparently it was he who caused the word *yantrarāja* (Sanskrit name for the astrolabe meaning 'king of instruments') to be engraved in Devanāgarī on both sides of the cartouche in the crown. The numerical values of the latitudes in Devanagari script were engraved on some plates (21°, 23;30°, 27°, 32°) for the benefit of those of his astronomers who did not read Arabic/Persian script. On the plate for Delhi, the name of the city is also engraved along with the latitude (*dīlī 28; 39*) in Devanagari as can be seen in Figure A051.8 above.

BIBLIOGRAPHY

Kaye 1918, p. 16, Figures 5 and 7. Lists it as Jaipur A.

Gunther 1932, I, no. 74, pp. 204-205, figs. 102 (rete) 103 (back).

A052 ASTROLABE ATTRIBUTABLE TO MUḤAMMAD MUQĪM[338]

Not dated, Lahore

Diameter 263 mm

PLU; ex-Alain Brieux, Paris; ex-Nachet, Paris

Répertoire 29

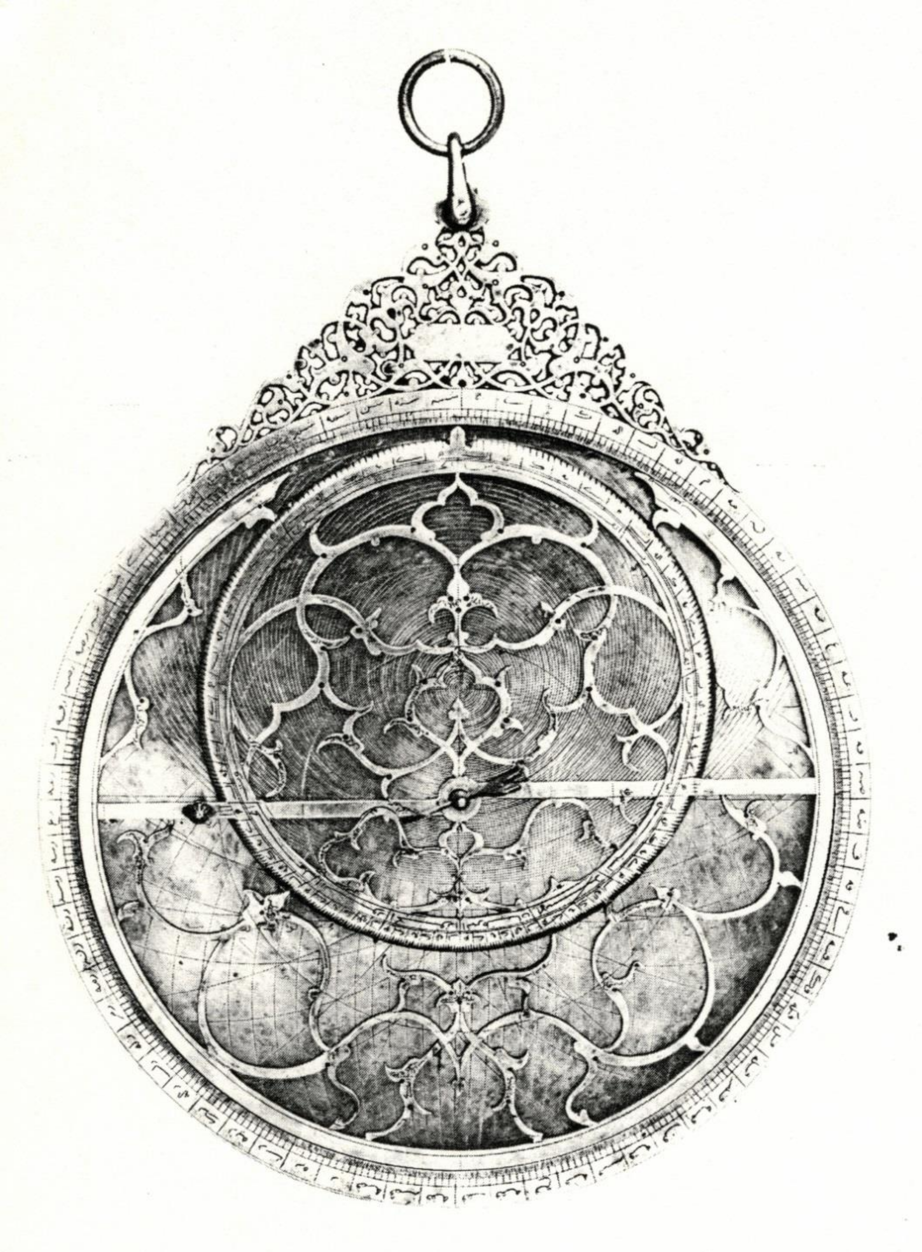

Figure A052.1 – Front of the astrolabe (photo from a Brieux catalogue)

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[338] Entry based on Alain Brieux, *Instruments scientifique du troisième siècle avant l'ère chrétinne à 1946,* Paris, Novembre 1983, p. 31, no. 13; also an unidentified catalogue of Alain Brieux where this astrolabe is illustrated and described under the serial number 10518.

This large and elegant astrolabe is not signed, nor dated, but there cannot be any doubt that it was made by Muḥammad Muqīm. The Répertoire notes that it has a great similarity to the astrolabe signed by Muqīm (A031).

The simple ring and shackle appear to be replacements. The multi-lobed *kursī* displays very fine fretwork with long-stemmed tulips with flared petals and a longish cartouche. The degree scale on the limb is divided in 1° and 5° and numbered in 5s from 5 to 360.

In the rete, the two rings of Capricorn and ecliptic are held together by the equinoctial bar which has a counter change at the centre. The ecliptic ring is divided into the 12 signs of zodiac and labelled with their names; each sign is divided into units of 5° and numbered accordingly. These units are further subdivided into 1° along the rim. There are said to be 37 star pointers which are joined by an elegant floral tracery. Inside the ecliptic ring, the tracery forms stylized trifoliate frames one upon the other along the solstitial colure.

The 5 plates serve the following latitudes: 21° and the tablet of ecliptic coordinates; 40° and 45°; 30° and 37°; 27° and 32°; tablet of horizons and a plate of unknown function. The plate visible under the rete has altitude circles for every 1° and azimuth curves for every 6° and lines and seasonal hours and equal hours counted from the western and eastern horizons.

On the back, the upper half of the rim carries the altitude scales divided in 1° and 5° and numbered as 5—90; 90— 5. In the upper left is the trigonometric quadrant with 60 horizontal parallels. In the upper right is the solar quadrant which is divided by the declination arcs into 6 zones, one for each pair of signs. Six curves for seasonal hours are drawn here which are numbered from 1 to 6.

In the lower half are drawn very small shadow squares, on the left for the base of 12 and on the right for 7. The scales are divided and numbered accordingly. Strangely, the vertical scale on the left is not accompanied by a label, while the remaining three are accompanied by the following, unusual, labels:

Horizontal scale on the left: *ẓill sullam bi-al-aṣābi*^{c}
Horizontal scale on the right: *ẓill sullam bi-al-aqdām*
Vertical scale on the right: *ẓill ma*^{c}*kūs bi-al-aqadām*

The lower half of the rim carries the cotangent scales. The scale on the right is marked 5, 10, 15, … 40, 45, 50, *ẓill aṣābi*^{c}. The scale on the right is marked 5, 10, 15, … 40, 45, *ẓill ma*^{c}*kūs bi-al-aqdām.*

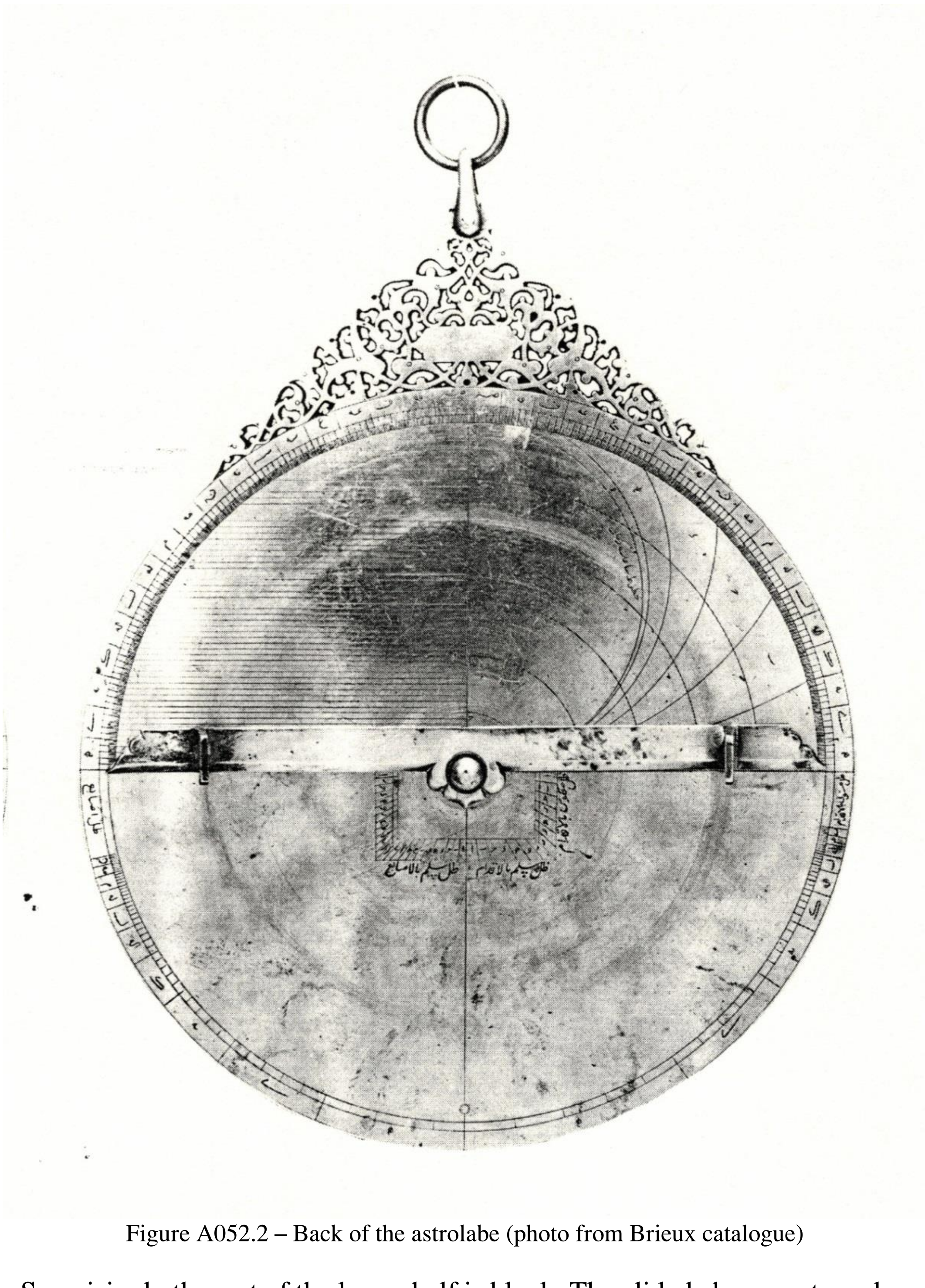

Figure A052.2 – Back of the astrolabe (photo from Brieux catalogue)

Surprisingly the rest of the lower half is blank. The alidade has ornate ends and an ornate centre piece, but carries no graduations.

A053 ASTROLABE ATTRIBUTABLETO MUḤAMMAD MUQĪM, NOT DATED[339]

Diameter 204 mm

PLU: ex-Alain Brieux, Paris

Figure A053.1 – Front of the astrolabe (photo from Brieux catalogue 1969)

339 Entry based on Alain Brieux, *Histoire des Sciences: Livres, Autographs, instruments, astrolabes …*, Paris 1969, no. 5819.

This large and well-crafted astrolabe is not signed, nor dated, but can certainly be attributed to Muḥammad Muqīm.

The *kursī* with multi-lobed profiles is elaborately reticulated, with a cartouche resembling a casket with a triangular base and a lid with a long oval handle. The finial imitates the form of the cartouche. The surface is engraved with decorative lines and small circles. The degree scale on the limb is divided in 1° and 5° and numbered in 5s from 5 to 360.

In the rete, the two rings of Capricorn and ecliptic are held together by a slender equinoctial bar which has a counter change at the centre. The ecliptic ring is divided into the 12 signs and labelled with their names; each sign is divided into units of 2° and numbered accordingly. There are said to be 40 star pointers. Probably there were originally two handles, one on the western end of the equinoctial bar, the other at 18° of Capricorn; both are now missing.

The catalogue states that there are 5 plates. In the photo, the tablet of ecliptic coordinates can be seen under the rete. On it are drawn latitude circles for each 1° and longitude circles for each 6°. The name of the plate *mīzān al-ᶜankabūt* can be seen at the bottom.

No information is available about the alidade. The pin, shown in the photo, appears to be original. The horse, also shown in the photo, is a replacement.

A054 ASTROLABE ATTRIBUTABLE TO MUḤAMMAD MUQĪM

Diameter 160

PLU; ex-London, Christie's

CCA 84

Figure A054.1 – Front of the astrolabe
(photo from the archives of the Museum of the History of Science, Oxford)

With two large bell or tulip-shaped incisions, the *kursī* in this astrolabe offers a new variation to the design that can be seen in three other astrolabes by Muqīm (A020, A021 and A048). Here the surface is embellished with winding tendrils joining tulips with two flared petals executed in very low relief. Therefore, this astrolabe must have been made by Muqīm. Remarkably, no astrological tables are engraved on the back, but two curves for the beginning and end of the mid-afternoon *ʿaṣr* at Lahore on latitude 32°.

COMPONENTS

Body with *kursī* (d. 160), shackle and ring, rete for 30 stars, 5 plates, alidade, pin and horse. Ring and shackle do not appear to be original.

FRONT

The ring and shackle are plain and do not appear to be original. The *kursī* is well crafted with six large incisions. The profiles are multi-lobed and the finial trifoliate. Both the sides of the *kursī* are embellished by decorations in low relief. The degree scale on the limb is divided in 1° and 5° and numbered from 5 to 360.

RETE

In the rete, the two rings of Capricorn and ecliptic are held together by the equinoctial bar which has a counter change at the centre. The ecliptic ring is divided into 12 zodiac signs and labelled with their names. Each sign is divided into 5 units of 6° each and numbered accordingly. The rim and edge of the ecliptic ring are calibrated in 1°. There are 30 named star pointers in the shape of tulip petals. These are joined by a nearly symmetrical tracery of tendrils with small leaves and flowers. There is a knob near the west point.

Table A054-1 Stars on the Rete

	Star Name	**Identification**
1	*Dhanab al-Qayṭus*	β Ceti
2	*Baṭn al-Ḥūt*	β Andromedae
3	*Al-Musalsala*	γ Andromedae

	Star Name	Identification
4	*Rās al-Ghūl*	β Persei
5	*Fam al-Qayṭus*	γ Ceti
6	*ᶜAyn al-Thawr*	α Tauri
7	*ᶜAyyūq*	α Aurigae
8	*Rijl al-Jawzā’ al-Yusrā*	β Orionis
9	*Yad al-Jawzā’ al-Yusrā*	γ Orionis
10	*Shiᶜrā Yamānī*	α Canis Majoris
11	*Shiᶜrā Shāmī*	α Canis Minoris
12	*Minkhar al-Shujāᶜ*	σ Hydrae
13	*Fard al-Shujāᶜ*	α Hydrae
14	*Qalb al-Asad*	α Leonis
15	*Ẓahr al-Asad*	δ Leonis
16	*Ṣarfa*	β Leonis
17	*Janāḥ al-Ghurāb*	γ Corvi
18	*Simāk Aᶜzal*	α Virginis
19	*Simāk Rāmiḥ*	α Bootis
20	*Nayyir Fakka*	α Coronae Borealis
21	*ᶜUnuq al-Ḥayya*	α Serpentis
22	*Qalb al-ᶜAqrab*	α Scorpii
23	*Rās al-Ḥawwā’*	α Ophiuchi
24	*Rās al-Jāthī*	α Herculis[340]

340 Wrongly placed.

	Star Name	Identification
25	*Nasr Wāqi*[c]	α Lyrae
26	*Minqār al-Dajāja*	β Cygni
27	[*Dhanab al-Jadī*][341]	δ Capricorni
28	[*Sāq Sākib al-Mā'*][342]	δ Aquarii
29	*Mankib al-Faras*	β Pegasi
30	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are 5 plates serving the following latitudes. The engraved values for duration of the longest days are not available.

Table A054-2 Plates

	φ	(locality)
1a	21;40°	(Mecca)
1b	25°	(Medina)
2a	27°	(Agra)
2b	31;50°	(Lahore)
3a	38°	
3b	45°	
4a	30°	
4b	Tablet of horizons	
5a	36°	

[341] Wrongly labelled as *Dhanab al-Ḥūt*.

[342] Wrongly labelled as *Dhanab al-Jadī*.

	φ	(locality)
5b	Tablet of ecliptic coordinates	

On all the plates (except 4b and 5b), altitude circles are drawn for each 3 degrees, azimuth circles for each 10°, curves for seasonal hours and for equal hours since sunset and until sunrise.

Geographical Gazetteer

There is an incomplete geographical gazetteer in two circles. The outer circle is filled with the names and coordinates of 47 places; the 24 cells in the inner circle are blank. No photo of the gazetteer is available.

Back

On the back, the upper half of the rim carries two altitude scales, divided in 1° and 5° and numbered 5—90; 90—5. In the upper left is a trigonometric quadrant with 60 horizontal parallels, i.e. one for each unit of the sixtieth division of the radius. In the upper right is a solar quadrant with arcs of solar declination for each 10° of the solar longitude. Every third circle, marking the boundary between two signs, is dotted. The signs are marked with their serial numbers along the two radii. There are three curves. The upper one carries the label *khaṭṭ al-zawāl* (line of midday). The other two are for the beginning and end of the mid-afternoon (*ᶜaṣr*) prayer with the labels *khaṭṭ awwal al-ᶜaṣr* (line of the begin of the prayer *al-ᶜaṣr*) and *khaṭṭ ākhir al-ᶜaṣr* (line of the end of the prayer *al-ᶜaṣr*) respectively.[343] But it is not specified for which latitude these three curves are drawn.

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343 King 2005, pp. 46-50, esp. p. 48, '… the beginning of the *ᶜaṣr* (B: shadow increase [from midday] equal to the length of the gnomon) and at the end of the *ᶜaṣr* (C: shadow increase equal to twice the length of the gnomon) …'

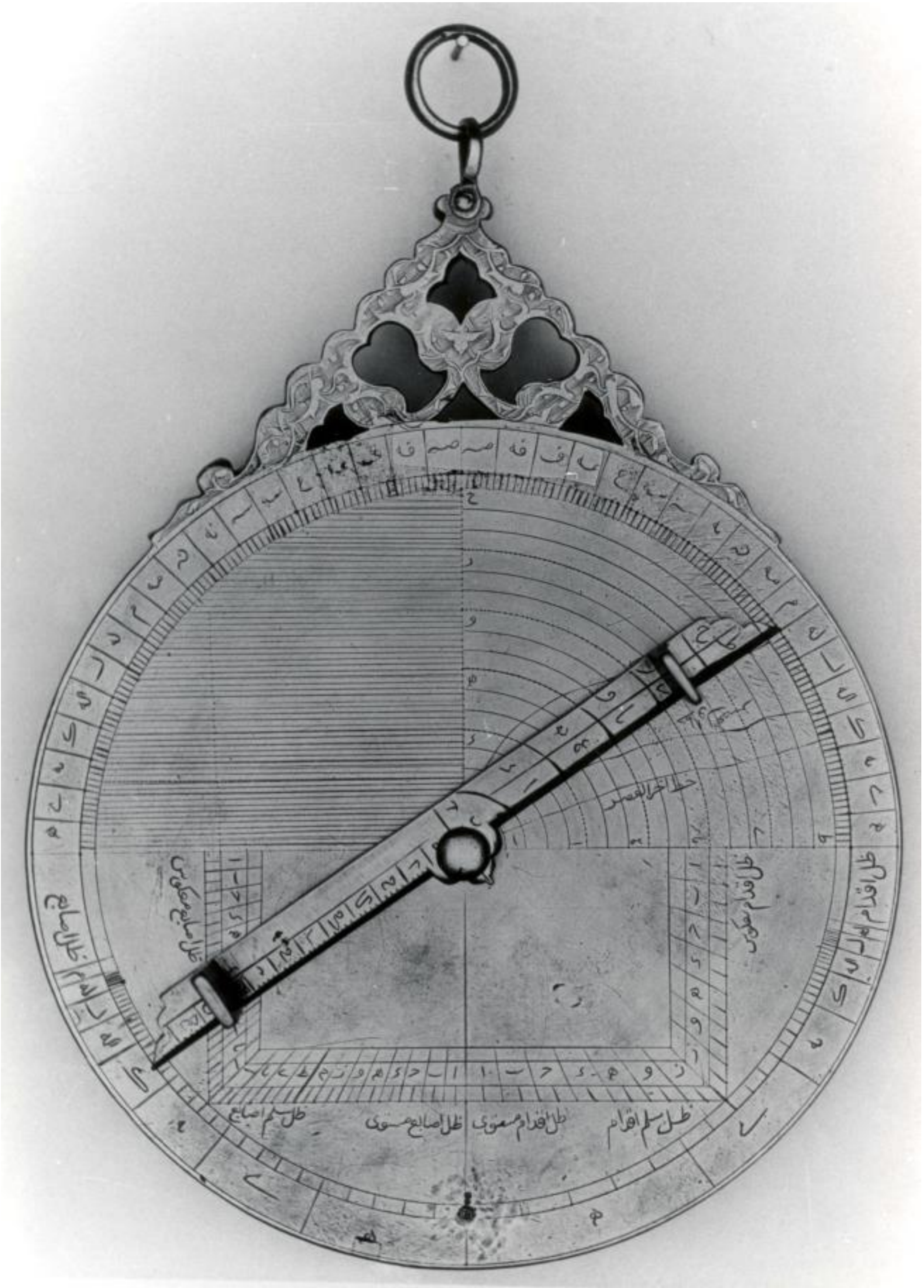

Figure A054.2 – Back of the astrolabe
(photo from the archives of the Museum of the History of Science, Oxford)

In the lower half, there are shadow squares, on the left for a base of 12 digits and on the right for a base of 6 feet. The vertical and horizontal scales on the left are divided into 12 units and in 24 units. The vertical scale is accompanied by the label *ẓill aṣābi*^{c} *ma*^{c}*kūs.* The horizontal scale has two labels: *ẓill aṣābi*^{c} *mustawī* and *ẓill sullam aṣābi*^{c}.

The scales on the right are divided into 7 divisions. Here the vertical scale has the label *ẓill aqdām maᶜkūs* and the horizontal scale *ẓill aqadām mustawī* and *ẓill sullam aqdām.*

The rim on the lower half is engraved with two cotangent scales, on the left in digits and on the right in feet. The unequal divisions in the scale on the left are numbered as 5, 10, 15, 20, 25, 30, 35, 40, followed by the label *ẓill aṣābiᶜ*. The divisions of the scale on the right are also numbered in the same way, but are followed by the label *ẓill aqdām.*

On the edge of the astrolabe, near the top, is engraved *Ṣāhib Maghfūr al-Ḥusaynī al-Jilānī* which must be the name of an owner.

ALIDADE

The alidade has ornate ends and an ornate centre piece. The right hand side is calibrated with a sexagesimal scale to match with the trigonometric quadrant and numbered in 5s from the centre up to the end from 5 to 60. The left hand side has a solar longitude scale marked with the serial numbers of the signs for use with the solar quadrant. The longish wedge is nicely shaped and decorated as the head of a horse.

PROVENANCE

This astrolabe was formerly in the Samuel Verplank Hoffmann Collection, New York, no. 5, and in New York Historical Society (Acc. no. 1943.195; Inv. no. 322464); it was loaned for some time to the Museum of History and Technology (now the National Museum of American History, Washington, D.C.). It came up for auction at Christie's thrice in 1975, 1990 and 1993. Its present location is not known.

BIBLIOGRAPHY

Gunther 1932, no. 88, p. 217.

Gibbs & Saliba 1984, no. 88, pp. 134-137.

Christie's catalogues of 9 April 1975 (lot 104, plate 14);[344] 29 March 1990 (lot 166) and 6 May 1993 (lot 114).

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[344] This catalogue proclaims: 'Indian astrolabes are relatively uncommon, the present being a good example of the earlier Persian influenced style.'

A055⊙ ASTROLABE ATTRIBUTABLE TO MUḤAMMAD MUQĪM, NOT DATED

Diameter 107 mm

Oxford, Museum of the History of Science (#54063)

CCA 1014

Figure A055.1 – Geographical gazetteer (photo by S. R. Sarma)

Of this well-crafted astrolabe with excellent calligraphy, only the mater and four plates survive. The astrolabe is neither signed nor dated. The *kursī* with two large bell-

shaped incisions resembles closely the *kursīs* in some of the astrolabes signed by Muḥammad Muqīm (A018, A021, A048,). Moreover, there is a close resemblance between the gazetteer of 69 places in this astrolabe and the same with 69 places in Muqīm's astrolabe of 1051/1641-42 (A026). Therefore, there cannot be any doubt that the present astrolabe is made by Muqīm. An unusual feature is the location of the plug inside the limb of the astrolabe which is situated at the North-West point and not at the north point as is the general practice. Consequently, the projections on the reverse sides of the plates had to be engraved upside-down so that the plug fits into the notch. On the tablet of horizons, the horizon at the latitude of 72° is shown as an eccentric circle with the label *ᶜarḍ 72*; this too is unusual.

COMPONENTS

Body with *kursī* (d. 107, h.136, t. 6), shackle, ring and 4 plates. The rete, alidade, pin and horse are missing.

FRONT

The ring is well made with a diamond cross-section; the trifoliate shackle also has a diamond cross section. The *kursī* is pierced with six large perforations, producing a pleasing design. The finial is trifoliate. The surface is smooth without any engravings.

The limb is graduated in 1°, 3°, 6°; labelled 6—90; 6—90; 6—90; 6—90.

PLATES

Inside the limb there is space for 5 plates, but only 4 plates are extant.

Table A055-1 Plates

	φ	Longest Day
1a	27°	13;43 hours
1b	32°	14;8 hours
2a	34°	14;22 hours
2b	18° + 30°	
3a	36°	14;32 hours
3b	40°	14;54 hours

	φ	Longest Day
4a	Tablet of ecliptic coordinates	
4b	Tablet of horizons	

On plates 1-3, altitude circles are drawn for each 6° and azimuth arcs for each 10° below the horizon. There are plain lines for seasonal hours and dotted lines for equal hours; the latter are for hours since sunset on some plates; on others for hours since sunset and hours before sunrise. The east and the west points are labelled; the meridian line is dotted; the prime meridian is dotted below the horizon.

Figure A055.2 – Tablet of horizons (photo by S. R. Sarma)

The tablet of ecliptic coordinates has latitude circles engraved for each 6° and longitude circles for each 10°; every third circle which forms the boundary between two consecutive signs is dotted. The name of the plate is engraved at the bottom as *ṣafīḥat mīzān al-ᶜankabūt.*

The tablet of horizons carries four sets of half horizons for latitudes 6° to 66°, with intervals of 8° in each set. There are declination scales divided in 2 units and labelled in 6s as 6, 12, 18, 23;30. The name of the plate is not engraved. Interestingly, a dotted circle is drawn eccentrically for the horizon at the latitude of 72° with the label *ᶜarḍ 72*. Muqim drew projections for the latitude of 72°, together with those for 0° and 90°, in some of his astrolabes (A030, A040, A047); in one undated astrolabe (A047), he drew projections exclusively for latitude 72° where the horizon is shown as an eccentric circle (Figure A047.3). But the horizon for 72° is rarely shown on the tablet of horizons (see also A058).

Geographical Gazetteer

The geographical gazetteer provides the longitudes, names and latitudes (in this order) for 69 localities in three circles. It is comparable to the gazetteer in A028.

Table A055-2 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
1	Qayrawān	41;0	31;40
2	Miṣr	63;20	30;20
3	ᶜAdan	76;0	11;0
4	Madīnat Ṭayyaba	75;20	25;0
5	Makka Musharraf	77;10	21;40
6	Ṭā'īf	77;30	21;20
7	Bayt al-Maqdis	66;30	31;50
8	Dimashq	70;0	33;15
9	Ḥalab	74;10	35;50
10	Marāgha	84;0	37;20
11	Tabrīz	82;0	38;0
12	Kūfa	79;10	31;30

	Place Name	L	φ
13	Baghdād	80;0	33;25
14	Baṣrah	84;0	30;11
15	Fīrūzābād	87;30	28;10
16	Shīrāz	88;0	29;36
17	Yazd	89;0	32;0
18	Qazwīn	85;0	36;0
19	Iṣfahān	86;40	32;25
20	Kāshān	86;0	34;0
21	Sabzawār	91;30	36;0
22	Mashhad	92;30	37;0
23	Harāt	94;20	34;30
24	Balkh	81;0	36;11
25	Badakhshān	84;24	37;10
26	Bukhārā	97;30	39;50
27	Samarqand	99;16	39;37
28	Khujand	100;35	41;55
29	Kāshghar	106;30	44;0
30	Khutan	107;0	42;0
31	Hurmūz	92;0	25;0
	Middle Circle		
32	Kirmān	91;30	30;5
33	Ghazna	104;20	33;35
34	Kābul	104;40	34;30
35	Dabīl	102;30	25;10

	Place Name	L	φ
36	Qandahār	107;40	33;0
37	Tubbat	110;0	40;0
38	Kashmīr	108;0	35;0
39	Multān	107;35	29;40
40	Lāhūr	109;20	31;50
41	Dihlī	113;35	28;39
42	Akra	115;0	26;43
43	Qannawj	115;50	26;35
44	Banāras	117;20	26;55
45	Kawāliyār	115;0	26;29
46	Barūj	112;5	21;20
47	Lahkanawtī	114;4	26;30
48	Kopāmaw	116;33	26;45
49	Karah Manakpūr	118;10	29;49
50	Ajmīr	112;0	26;0
51	Awadh	118;6	27;22
52	Baran	114;0	28;48
53	Kol Jalālī	114;19	28;4
54	Badāūn	114;59	27;32
	Inner Circle		
55	Kalpī	116;45	26;56
56	Jawnbūr	119;6	26;36
57	Jadda	76;0	21;0
58	Ujjayn	110;50	23;30

	Place Name	L	φ
59	Narwar	114;0	25;20
60	Mandū	112;25	22;15
61	Burhānpūr	113;0	20;30
62	Dawlatābād	111;0	20;30
63	Juyūl	106;40	19;0
64	Aḥmadābād	108;40	23;15
65	Kolkanda	114;20	28;4
66	Bijāpūr	105;30	16;20
67	Sarāndib	104;0	10;0
68	Jamkūt	177;0	5;0
69	Baykanil?	97;30	19;45

BACK

The rim of the two upper quadrants carries altitude scales which are divided in 1°, 3°, 6° as in the front and numbered in 6s as 6—90; 90—6. The rim of the lower half is engraved with the scales of cotangents and their subdivisions.

In the upper left quadrant, there are 30 horizontal parallels, every third highlighted with dots. The upper right quadrant is divided by dotted quarter circles into 6 zones, each representing a pair of signs; each sign is subdivided into decans by plain quarter circles. The signs are labelled with their serial numbers from 0 to 11and the decans as 10, 20, 30 along the two radii. On this quadrant are drawn two solar meridian altitude graphs for the latitudes 27° and 32° with the usual labels.

In the lower half, there are shadow squares, on the left for the base of 12 and on the right for 7, with the usual divisions and labels. Within the shadow squares are two semi-circular rows containing the names of the 28 lunar mansions and the 12 corresponding zodiac signs, the latter indicated by their serial numbers from 0 to 11.

Figure A055.3 – Back of the astrolabe (photo by S. R. Sarma)

PROVENANCE

Formerly in the private collection of Henri Michel; donated by Billmeir to the Museum of the History of Science.

A056 ASTROLABE ATTRIBUTABLE TO MUḤAMMAD MUQĪM, NOT DATED

Diameter 105 mm

PLU, ex-London, Christie's (auction catalogue of 7 Match 1991, lot 86)

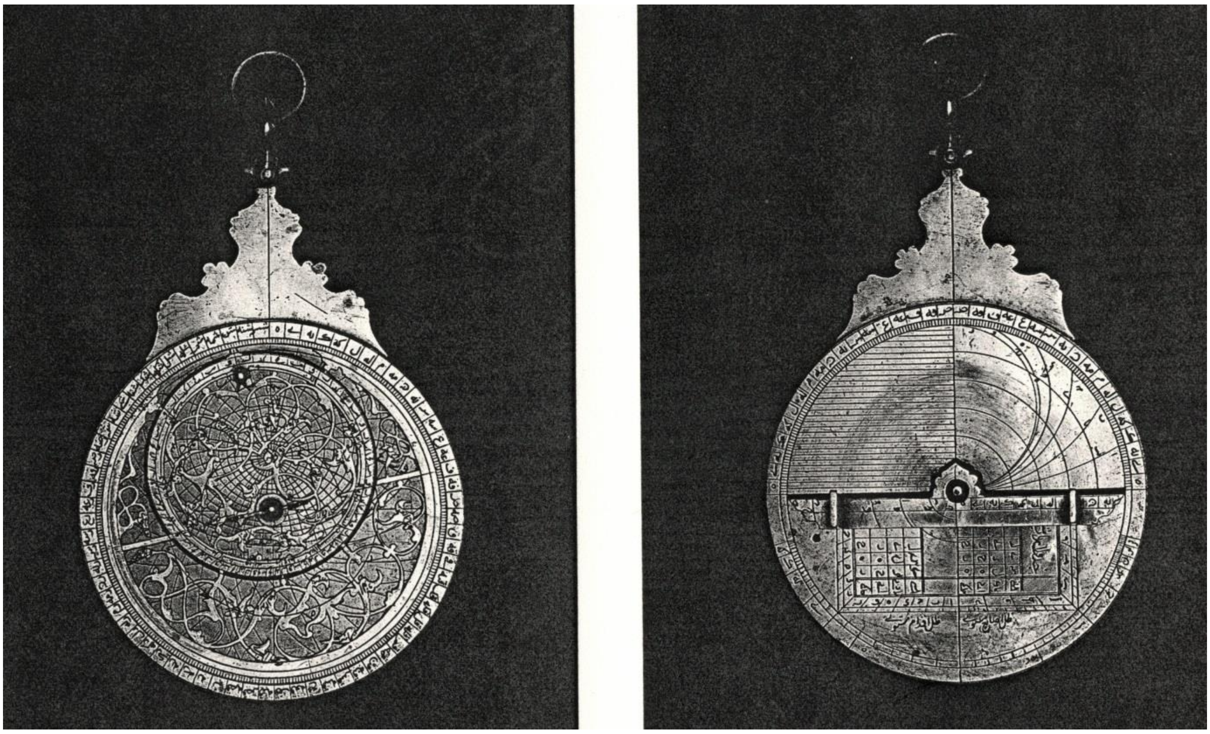

Figure A056.1 – Front and back views of the astrolabe (© Christie's, London)

With the extravagant form of its *kursī,* this astrolabe looks exactly like the astrolabe at the Institut du Monde Arabe, Paris (A042). Both have the same diameter of 105 mm, but there is a subtle difference in the design of the tracery in the rete. In the astrolabe at Paris, the tracery inside the ecliptic ring winds like a spiral and comes to stop midway between the centre of the rete and the southern tip. But here, the tracery makes loops around the inner edge of the ecliptic ring. More differences, but also similarities, can be seen on the back.

COMPONENTS

Body with *kursī* (d. 105), shackle and ring, rete, 4 plates, alidade, pin and wedge.

FRONT

The ling is very large; the shackle is of trifoliate shape. The high *kursī* is solid and plain, but the profiles are flamboyant with tri-lobed protuberances. The degree scale on the limb is divided in 1° and 5° and numbered from 5 to 360.

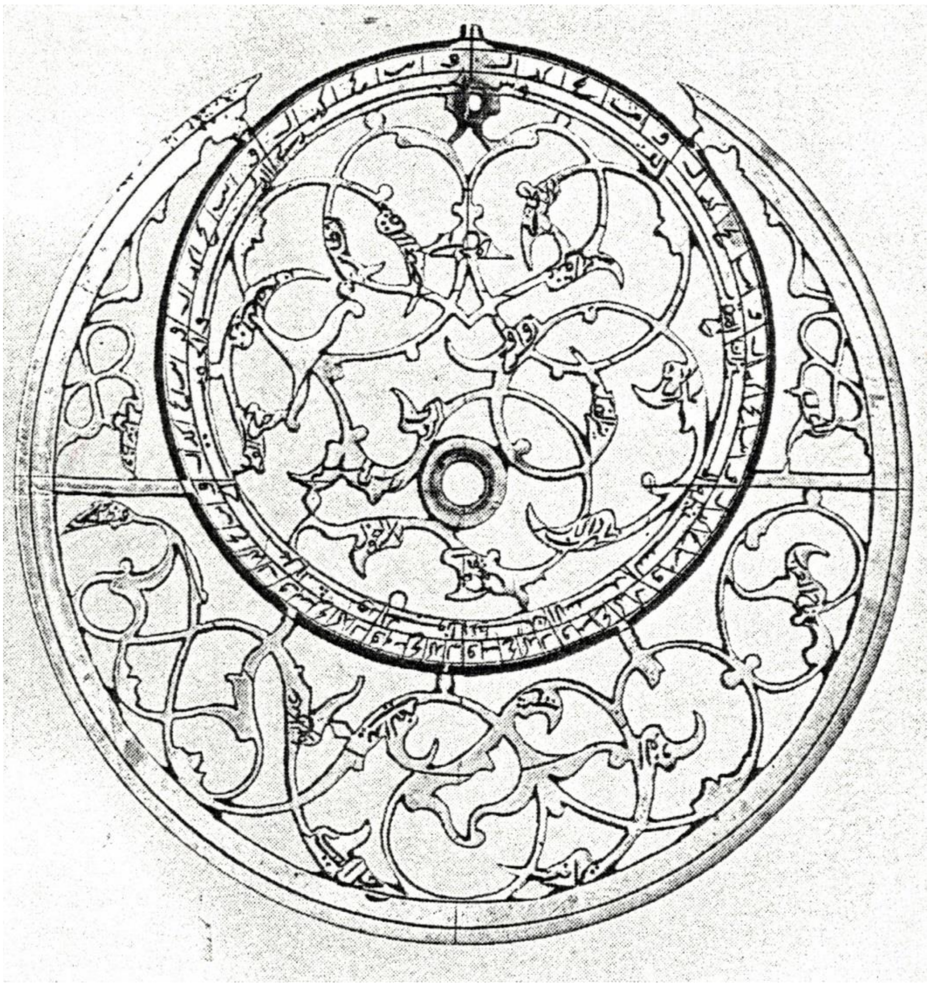

Figure A056.2 – Rete of the astrolabe (© Christie's, London)

Rete

The peripheral Capricorn ring and the ecliptic ring are joined by the equinoctial bar and the floral tracery that joins the star pointers. Unusually, the equinoctial bar is not represented in full; only two segments in the east and west situated between the rings are shown. The upper edge of the eastern segment and the lower edge of the western segment lie on the equinoctial colure. The ecliptic ring is divided in 12 signs of the zodiac and labelled with their names; each sign is divided in units of 6° and numbered accordingly. Traces of the broken lines of the equinoctial and solstitial colures are visible. There are about 25 named star pointers. There is a handle at the top, just below the ecliptic ring.

Plates

There are four plates; three plates are designed for latitudes 22° and 29°, 32° and 34°, 37° and 42°. The fourth plate is engraved with the tablet of ecliptic coordinates on one side and with the tablet of horizons on the other. The numerical values of latitudes

and hours are engraved in the same line after the argument. The photos of these plates are published in Christie's catalogue, but the values of the maximum duration of the daylight are difficult to read in those photos. In the tablet of horizons, there are eight sets of half horizons which are not properly numbered. The declination scales are drawn only twice, not along the diameters, but obliquely at the SW. These scales are not numbered.

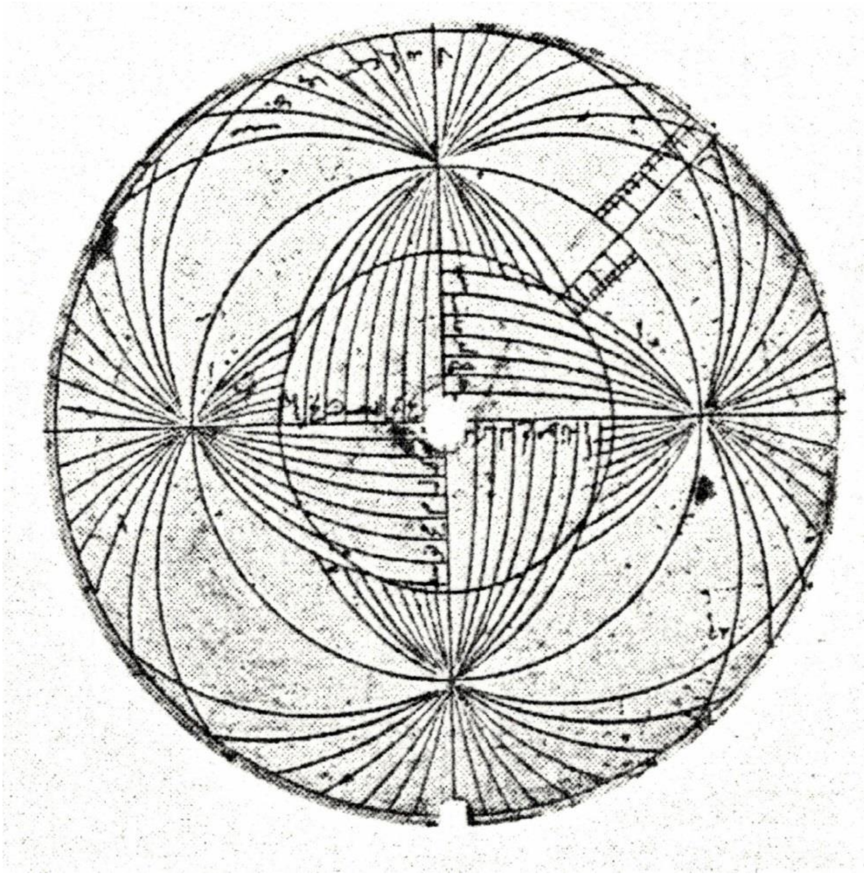

Figure A056.3 – Tablet of horizons (© Christie's, London)

GEOGRAPHICAL GAZETTEER

No information is available about the geographical gazetteer.

BACK

On the back, the rim of the upper half carries two altitude scales divided in 1° and 5° and numbered as 5—90; 90—5. In the upper left is a trigonometric quadrant with 30 horizontal parallel lines. The upper right quadrant is divided by solar declination arcs into 6 zones, one each for a pair of zodiac signs. Neither the names of the signs, nor their serial numbers are engraved along the two radii. Here is engraved also a universal

horary quadrant with 6 hour lines. From the horizontal radius up to the vertical radius, the hours are numbered from 1 to 6, and in the reverse direction from 7 to 12.

Shadow squares are drawn in the lower half, on the left for a gnomon of 7 feet and on the right for a gnomon of 12 digits. The vertical and horizontal scales on the left are divided into 7 units and numbered accordingly. On the right, the scales are first divided into 4 units and then in a parallel column in 12 units. They are numbered in 3s as 3, 6, 9, 12. The vertical scales do not carry any labels; the horizontal scale on the left has the label *ẓill aqdām mustawī* and that on the right *ẓill aṣābi*ᶜ *mustawī.*

The rim on the lower half is engraved with cotangent scales. The unequal divisions of the cotangent scale on the left are numbered as is 5, 10, 15, 20, 25, but there is no label thereafter. There is a division of 7, but it is not numbered. These divisions are subdivided into 5 units in the parallel column. The unequal divisions of the cotangent scale on the right are numbered as 6, 12, 18, 24, 30, 36, 42, without a label thereafter. These divisions are subdivided into 5 units in the parallel column.

Within the shadow squares, there are two small tables of the triplicities with the heading *jadwal arbāb muthallathāth* (table of the regents of the triplicities).

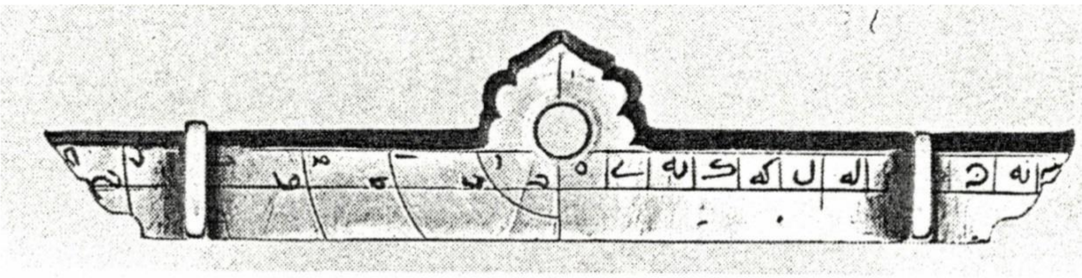

Figure A056.4 – Graduated alidade (© Christie's, London)

ALIDADE

The alidade has ornate ends and an ornate centre piece. The right hand side is calibrated with a sexagesimal scale to match with the trigonometric quadrant and numbered in 5s from the centre up to the end from 5 to 60. The left hand side has a solar longitude scale marked with the serial numbers of the signs for use with the solar quadrant. The wedge is of silver.

BIBLIOGRAPHY

Christie's catalogue of 7.3.1991, lot 86, with a full set of photos.

A057 ASTROLABE ATTRIBUTABLE TO MUḤAMMAD MUQĪM, NOT DATED

Diameter 100 mm

Hyderabad, Saidiya Library

Figure A057.1 – Front of the astrolabe (photo by Ahmad Athaullah)

A highly interesting miniature astrolabe with many unusual features, such as the lines for the beginning and end of the *ᶜaṣr* prayers at 27° and 32° on the back (cf. A040 and A054), crepuscular prayer lines on the plates, interesting composite projections in plate 6a, and western type of horizons.

COMPONENTS

Body (d. 100, h. 120, t. 10) with ring, shackle, rete, 6 plates, alidade, pin, washer, wedge (?), wooden case.

FRONT

The *kursī* is solid and plain with two large eyelets on the sides in the style of the Kufic astrolabes as in A047 and A048. The finial is trifoliate but not pronounced. The shackle is large and of trifoliate shape. The limb is graduated in 1° and 6° and numbered in 6s from 6 to 360.

Figure A057.2 – Rete of the Astrolabe (photo by Ahmad Athaullah)

RETE

The peripheral Capricorn ring is very slender and the ecliptic ring very wide; these two are held together by the equinoctial bar which changes counter four times. The circles of the Tropic of Cancer and of the ecliptic are well marked in their respective rings. Traces of the equatorial circle and of the Tropic of Cancer are visible on the ecliptic ring. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names. Each sign is subdivided in groups of 6° and numbered accordingly. The 22 star pointers to the south of the ecliptic and 19 to the north are joined by unconnected segments of tracery. There is a handle on the rim at the NW point.

PLATES

There are six plates. They do not have a notch at the north point as is the general practice, but a hole, as large as the hole and the centre, on the meridian a little above the north point. At the same place on the inner side of the mater is a pin which receives the plates.

Table A057-1 Plates

	φ	Longest Day	
1a	25°	13;25 hours	crepuscular prayer lines
1b	22°	13;22 hours	north + south projection ?
2a	0°+90°		
2b	18°+ 72°		
3a	40°	14;54 hours	crepuscular prayer lines
3b	36°	14;22 hours	crepuscular prayer lines
4a	27°	13;46 hours	crepuscular prayer lines
4b	32°	14;8 hours	crepuscular prayer lines
5a	30°+72°		
5b	Tablet of ecliptic coordinates		
6a	Tablet of horizons (western type, 8 sets of horizons)		
6b	27°+32°		

φ	Longest Day

On 5 plates there are crepuscular or twilight prayer lines 18° below the horizon. They carry labels *ṭulūʿ al-fajr* (rise of the morning twilight) on the east and *maghīb al-shafq* (setting of the evening twilight) on the west.

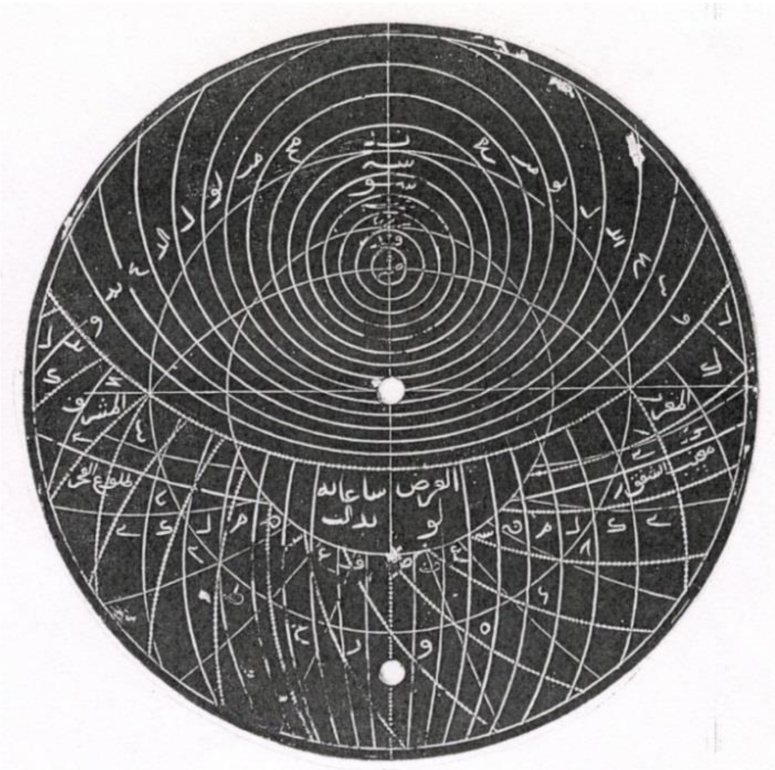

Figure A057.3 – Plate for latitude 36° (photo by Ahmad Athaullah)
Notice the crepuscular lines below the horizon and the labels in the east and west.

Plate 1b is calibrated for latitude 22°. On this plate altitude circles are drawn also below the horizon in a southern projection (cf. Figure A013.6)

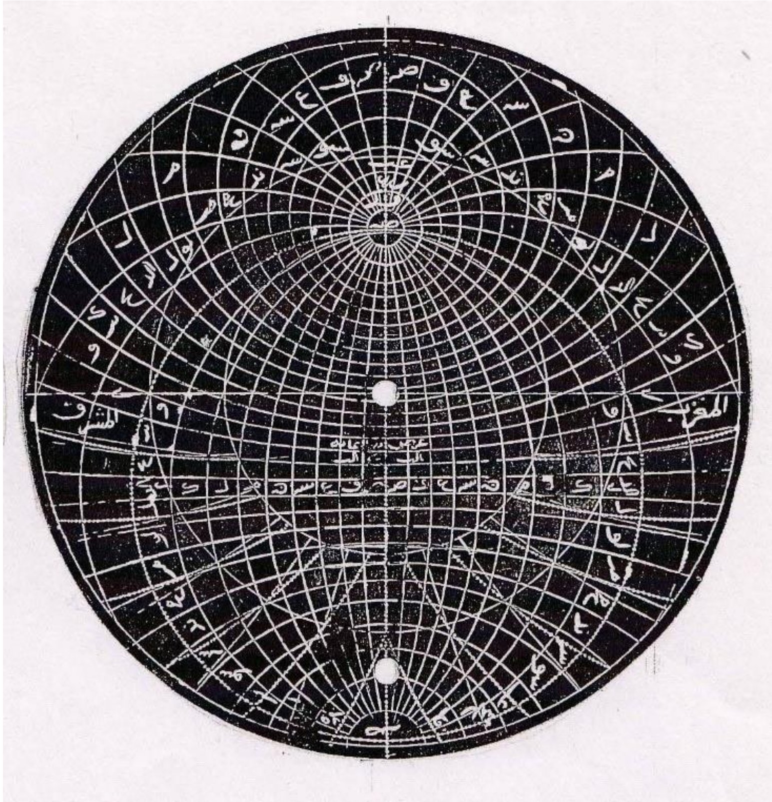

Figure A057.4 – Plate 1b for latitude 22° (photo by Ahmad Athaullah)

On 6b, are composite projections of 27° and 32°. There are two families of arcs representing 6° of astrologiacal houses at these latitudes. [345]

[345] Similar arcs are to be seen on the plate to be used with the Zawraqi horizons in Qāi'm's astrolabe of 1635 (A013).

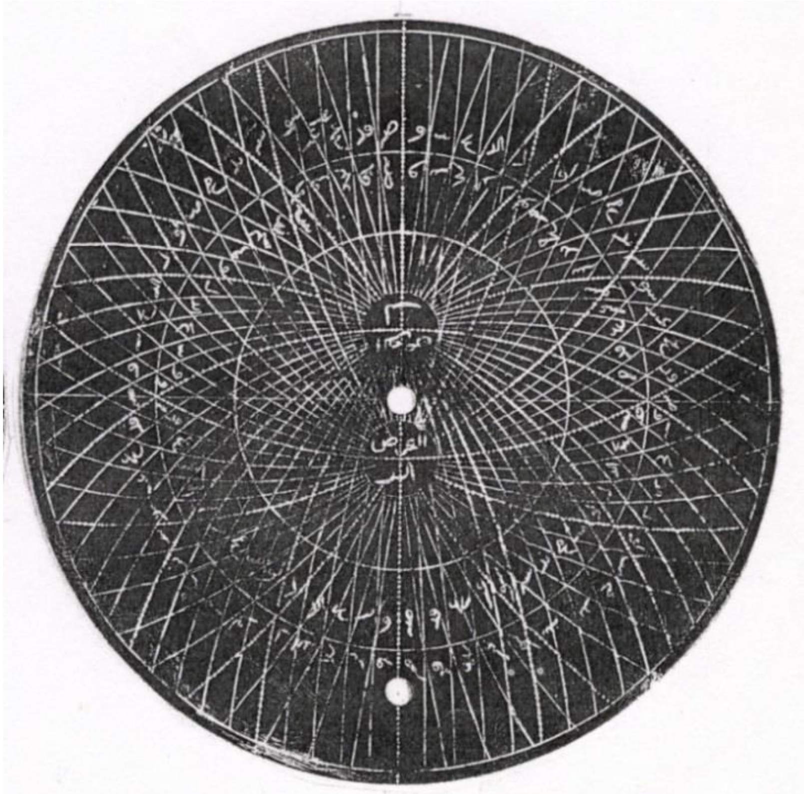

Figure A057.5 – Composite plate for latitudes 27° and 32° (photo by the Owner)

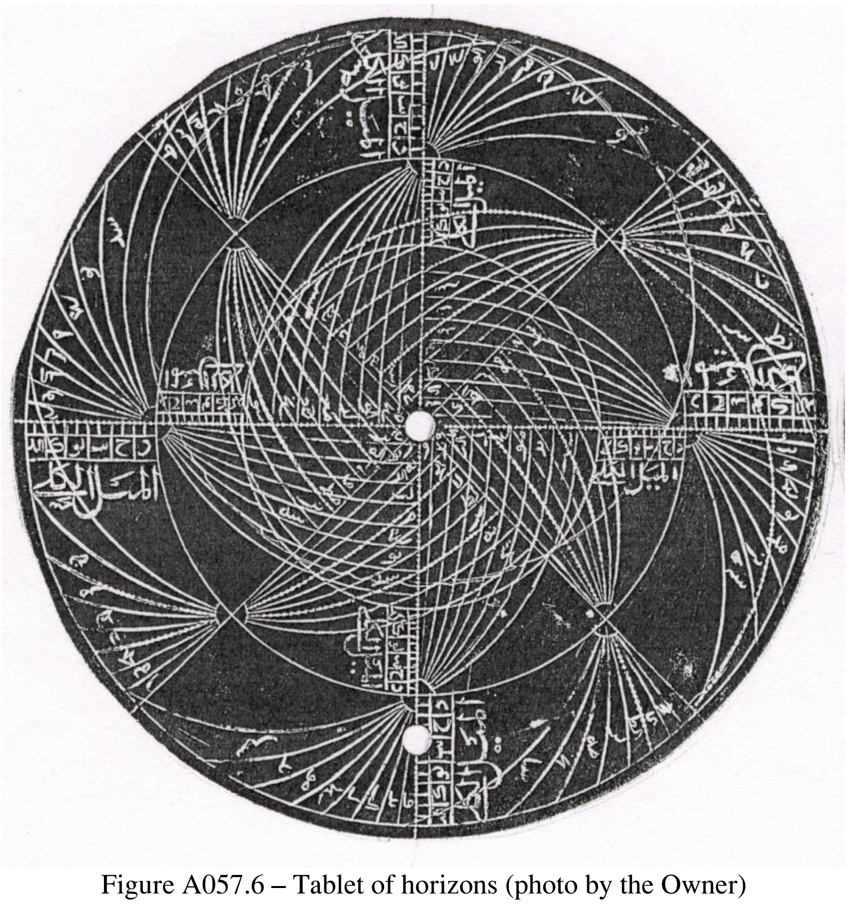

Figure A057.6 – Tablet of horizons (photo by the Owner)

On the tablet of horizons are engraved 8 sets of half horizons for each degree of latitude from 6° to 67°. The half horizons are arranged in the style of the astrolabes of the Maghrib.

6	14	…	54	62
7	15	…	55	63
8	16	…	56	64
9	17	…	57	65
10	18	…	58	66
11	19	…	59	67
12	20	…	60	
13	21	…	61	

Declination scales are engraved along the horizontal and vertical diameters, once each between the Tropic of Capricorn and equator and between the equator and the Tropic of Cancer. The scales are divided in 2° and numbered in 4s from 4 to 22. They are accompanied by the label *al-mayl al-kullī* (the maximum declination). But the name of the plate is not engraved.

Figure A057.7 – Geographical gazetteer (photo by Ahmad Athaullah)

GEOGRAPHICAL GAZETTEER

On the inner side of the mater is engraved, very neatly and in two concentric bands, a geographical gazetteer which contains the names, longitudes and latitudes of 54 localities.

Table A057-2 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
1	Miṣr	63;20	30;20
2	Madīnat Rasūl	75;20	25;0

	Place Name	L	φ
3	Makka Mubārak	77;10	21;40
4	Bayt al-Maqdis	66;30	31;50
5	Dimashq	70;0	33;15
6	Ḥalab	72;10	35;50
7	Maragha	87;10	34;20
8	Tabrīz	82;0	38;0
9	Kūfa	79;10	31;30
10	Baghdād	80;0	33;25
11	Baṣra	84;0	30;11
12	Fīrūzābād	87;30	28;10
13	Shīrāz	88;0	29;36
14	Yazd	89;0	32;0
15	Qazwīn	85;0	36;0
16	Iṣfahān	86;40	32;25
17	Kāshān	86;0	34;0
18	Bistām	89;30	36;10
19	Sabzawār	91;30	37;0
20	Mashhad	92;6	37;0
21	Harāt	94;20	34;30
22	Balkh	101;0	36;41
23	Badakhshān	104;24	37;10
24	Bukhārā	97;30	39;50
25	Samarqand	99;36	39;37
26	Khujand	100;35	41;55

	Place Name	L	φ
27	Kāshghar	106;30	44;0
28	Khutan	107;0	42;0
29	Hurmūz	92;0	25;0
30	Kirmān	91;30	30;5
31	Ghazna	104;20	33;35
32	Kabul	104;40	34;30
33	Dabīl	102;30	25;10
34	Qandahār	107;40	33;0
35	Tubbat	110;0	40;0
	Inner Circle		
36	Kashmīr	108;0	35;0
37	Lāhūr	109;20	31;50
38	Haḍrat Dihlī	114;33	28;33
39	Ākra	114;0	27;13
40	Qannawj	115;50	26;35
41	Bānāras	117;20	26;55
42	Kawāliyar	115;0	26;29
43	Baruj	101;5	21;20
44	Kālpī	117;45	25;56
45	?	108;45	32;30
46	Jawnbūr	119;6	26;36
47	Kara	117;6	26;36
48	Jadda	76;0	21;0
49	Ajmīr	110;50	23;30

	Place Name	L	φ
50	Bījābūr	105;30	-- --
51	Burhānbūr	103;4	20;30
52	Kūlkanda	114;19	-- --
53	Sarāndīb	130;0	10;0
54	Kanbayāt	109;4	22;20

Figure A057.8 – Back of the astrolabe (photo by Ahmad Athaullah)

BACK

The rim of the upper half carries altitude scales divided in 1° and 6° and numbered in 6s as 6—90; 90—6. In the upper left is engraved a trigonometric quadrant with 60 equidistant horizontal parallels, with every sixth highlighted with dots. Radials are drawn for each 6° of arc to facilitate the determination of cosines. Every sixth line of these parallels is highlighted with dots.

On the upper right is a solar quadrant, with a circle of declination each for a pair of zodiac signs. Upon these circles horizontal parallels are stereographically projected, one for each 3° of arc. Every alternative line of these parallels is highlighted as a dotted line. Superimposed upon this grid are two curves for the solar meridian altitude for all seasons. The upper one is dotted; it is for the latitude 27° (Agra) and carries the label: *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27.* The lower curve is plain and meant for the latitude 32°. It carries the label *khaṭṭ niṣf al-nahār bi-ᶜarḍ* 32. Below this pair there is a second pair of dotted and plain curves, with the labels [*khaṭṭ*] *awwal ᶜaṣr 27* and [*khaṭṭ*] *awwal ᶜaṣr 32* (line of the begin of the mid-afternoon prayer *ᶜaṣr* at latitudes 27° and 32°). This is followed by a third pair of dotted and plain curves with the labels [*khaṭṭ*] *ākhi*[*r*] *ᶜaṣr 27* and [*khaṭṭ*] *ākhir ᶜaṣr 32* (line of the end of the afternoon prayer). These two additional sets of curves show the times of the beginning and end of mid-afternoon prayer called *ᶜaṣr*.

Figure A057.9 – Upper right quadrant on the back with the prayer lines (photo by the Owner)

Two shadow squares are engraved in the lower half, on the left for the base of 7 and on the right for the base of 6 and 12; the vertical and horizontal scales on both sides are divided, numbered and labelled accordingly.

Inside the shadow squares is a table with the heading *faḍl al-dawr* (excess of revolution).

The rim of the lower half is engraved with the cotangent scales and their subdivisions in two semi-circular rows. The next 6 semi-circular rows contain the names of the 28 lunar mansions, the names of 12 zodiac signs, the limits of the signs and the decans and their regents.

ALIDADE

The alidade has ornate ends and ornate centre-piece. The right hand side is endowed with a sexagesimal scale matching with the divisions on the upper left

quadrant; the left hand side is engraved with a zodiac scale to match the divisions on the upper right quadrant. There is a nicely carved wooden box for the astrolabe.

Figure A057.10 – Wooden box for the astrolabe (photo by Ahmad Athaullah)

A058☉ ASTROLABE BY MUḤAMMAD MUQĪM, NOT DATED

Diameter 92 mm

Leiden, Museum Boerhaave (A 277)

CCA 1097

Figure A058.1 – Front of the astrolabe (photo by Professor Jan Houben)

The signature on the back of this well-crafted astrolabe states that it is the 'work of the servant Muḥammad Muqīm' (*ᶜamal al-ᶜabd muḥammad muqīm*). In a long study of this astrolabe, published in 1948, C. A. Crommelin, the then director of the Museum Boerhaave,[346] assumed that this Muḥammad Muqīm is the Muḥammad Muqīm of the well-known Lahore family.[347] But a closer examination of the astrolabe shows that it differs considerably from the astrolabes signed by Muḥammad Muqīm of Lahore. For one thing, the signature merely mentions the name Muḥammad Muqīm without any reference to the forefathers as is usually done on the Lahore astrolabes. There is no plate calibrated for the latitudes of 27° and 32° on its two sides, nor are there solar meridian altitude curves for these latitudes on the back, which are invariably present in all the astrolabes signed by Muḥammad Muqīm of Lahore. Furthermore, there are several features in this astrolabe which differ from the extant astrolabes made by Muḥammad Muqīm of Lahore. Strangest of all is that on the star pointers of the rete, aside from the names of 38 fixed stars, the names of five terrestrial cities are engraved, these being Baghdād, Makka, Mashhad, Madīna and Kūfa

There is another astrolabe maker of the same name, viz. Muḥammad Muqīm al-Yazdī, who is almost contemporaneous to Muqīm of Lahore. Five of his astrolabes are said to be extant. One of these, dated AH 1057 (AD 1047-48) is with the Museum of the History of Science, Oxford (45747); another, undated, is at the National Maritime Museum, Greenwich (AST0566). Stylistically, these astrolabes differ markedly from the present astrolabe at Leiden.

Between the two Muḥammad Muqīms then, the one from Lahore is more likely to be the maker of the present astrolabe. Therefore, this is astrolabe is included in his oeuvre.

COMPONENTS

Body with *kursī* (d. 92, h. 118, t. 5.5), shackle, ring and cord, rete for 38 stars, 4 plates (d. 80), rule, alidade, pin and wedege. Ring, shackle, rule and wedge are probably replacements.

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346 Crommelin 1948.

347 Crommelin 1948, p. 25: 'Lahore, le domicile du constructeur, a une latitude de 31°30′….'.

FRONT

The *kursī* has lobed profiles and a trifoliate finial; it is elegantly fretted with large symmetric perforations; two hour-glass shaped motifs are on the central vertical line.

The limb is divided in 1° and 5° and numbered in 5s as 5—360. The *abjad* numerals are written upside down (i.e. the upper parts of the letters are towards the centre of the astrolabe), which is somewhat unusual.

RETE

The peripheral Capricorn ring and the ecliptic ring are held together by the equinoctial bar which is counter-changed at the equinoxes. A segment of solstitial bar runs from the centre to the upper rim, but bifurcates itself before reaching it. The ecliptic ring is divided into the twelve signs of the zodiac and labelled with their names. Each sign is divided in groups of 6° and the divisions are numbered accordingly as 6, 12, 18, 24 and 30. A round handle is attached on the peripheral ring slightly to the left of the north point. There are 36 mainly leaf-shaped star pointers. The tracery joining the star pointers is not continuous, but consists of separate clusters, each joining a few star pointers. On the leaves and on the tendrils which join them, there are deeply-cut decorative lines. This feature is not seen in the astrolabes signed by Muqīm of Lahore. The star list reproduced below is substantially after Crommelin, but here it is rearranged in the order of increasing right ascension; some stars which Crommelin did not notice are added here.

Figure A058.2 – Rete of the Astrolabe (photo by Professor Jan Houben)

Table A058-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab [al-Qayṭus] Shamālī*	ι Ceti
2	*Dhanab [al-Qayṭus Janūbī]*	β Ceti
3	*Dhanab al-Musalsala*[348]	β Andromedae

348 Engraved as Ḥanab al-Musalsalah.

	Star Name	Identification
4	*Ṣadr al-Qayṭus*	π Ceti
5	*Fam [al-Qayṭus]*	γ Ceti
6	*Mirfaq al-Ghūl*	α Persei
7	*Tālī Masāfat [al-Nahr]*	γ Eridani
8	*ᶜAyn al-Thawr*	α Tauri
9	*Rijl al-Yusrā*	β Orionis
10	*Yad al-Yusrā*	γ Orionis
11	*Yad al-Yumnā*	α Orionis
12	*Rijl [al-Yumnā]*	κ Orionis
13	*Shiᶜrā Yamānī*	α Canis Majoris
14	*Shiᶜrā Shāmī*	α Canis Minoris
15	*Ṭarfat al-Safīna*	ρ Puppis
16	*Fard al-Shujāᶜ*	α Hydrae
17	*Qalb al-Asad*	α Leonis
18	*Ẓahr al-Dubb*[349]	α Ursae Majoris
19	*Qā ᶜidat [al-Bāṭiya]*	α Crateris
20	*Janāḥ al-Ghurāb*	γ Corvi
21	*Qā'id [al-Dubb]*	η Ursae Majoris
22	*Simāk Aᶜzal*	α Virginis
23	*[Simāk] Rāmiḥ*	α Bootis
24	*Nayyir al-Fakka*	α Coronae Borealis
25	*ᶜUnuq al-Ḥayya*	α Serpentis

[349] Engraved as *Dūb.*

	Star Name	Identification
26	*Rukbat [al-Ḥawwā']*	ε Ophiuchi
27	*Qalb al-ᶜAqrab*	α Scorpii
28	*Mirfaq al-Ḥawwā'*	κ Ophiuchi
29	*Rās [al-Ḥawwā']*	α Ophiuchi
30	*[Nasr] Wāqiᶜ*	α Lyrae
31	*Dhanab al-ᶜUqāb*	ζ Aquilae
32	*Minqār al-Dajāja*	β Cygni
33	*Nasr Ṭā'ir*	α Aquilae
34	*Dhanab [al-Dajāja]*	α Cygni
35	*Fam [al-Faras]*	ε Pegasi
36	*Dhanab al-Jadī*	δ Capricorni
37	*Mankib al-Faras*	β Pegasi
38	*Kaff [al-Khaḍīb]*	β Cassiopeiae

It is strange that the stars include *Mirfaq al-Ghūl* (α Persei) instead of the more common *Rās al-Ghūl* (β Persei). *Qā'id al-Dubb* (η Ursae Majoris) and *Dhanab al-ᶜUqāb* (ζ Aquilae) are also rarely used in the Lahore astrolabes.

Most unusual is that the names of five terrestrial localities are engraved on star pointers: Baghdād (*a*), Makka (*b*), Mashhad (*c*), Madīna (*d*) and Kūfa (*e*). The purpose of these terrestrial names in the stellar regions is inexplicable.

PLATES

There are four plates, each with a rectangular notch at the north point, to fit into the peg at the corresponding place in the mater. Strangely there is no plate calibrated on one side for latitude 27° (Agra) and on the other for latitude 32° (Lahore); such a plate occurs invariably in all astrolabes made by Muḥammad Muqīm of Lahore. Plate 2a is made for the latitude of Delhi at 29°, but this capital city of India is not mentioned in the geographical gazetteer which, however, includes Agra and Lahore.

Table A058-2 Plates

	φ	Longest Day
1a	24°	13;30 hours
2a	29°	13;52 hours
3a	30°	13;58 hours
2b	34°	14;19 hours
3b	36°	14;28 hours
1b	37°	14;34 hours
4a	0°+ 90°	
4b	Tablet of horizons	

Plates 1-3 have altitude circles traced for every 6°. Under the western and eastern horizons *al-maghrib* and *al-mashriq* are inscribed respectively. The azimuth arcs and hour circles vary from plate to plate. On some plates (24°and 29°) there are no azimuth arcs at all.

On three plates (29°, 30° and 34°), seasonal hours are marked with ordinal numbers which are engraved just below the circle of equator: *al-awwalī* (the first), *al-thāniyah, al-thālitha, al-rābi*^{c}*a, al-khāmisa, al-sādisa, al-sābi'a, al-thāmina, al-tāsi*^{c}*a, al-*^{c}*āshira, al-hādī* ^{c}*ashr, al-thāniya* ^{c}*ashr.* On plate 2a for 29° and on 2b for 34°, both the seasonal hours and the equal hours counted from the western horizons have the ordinal numbers as common labels.

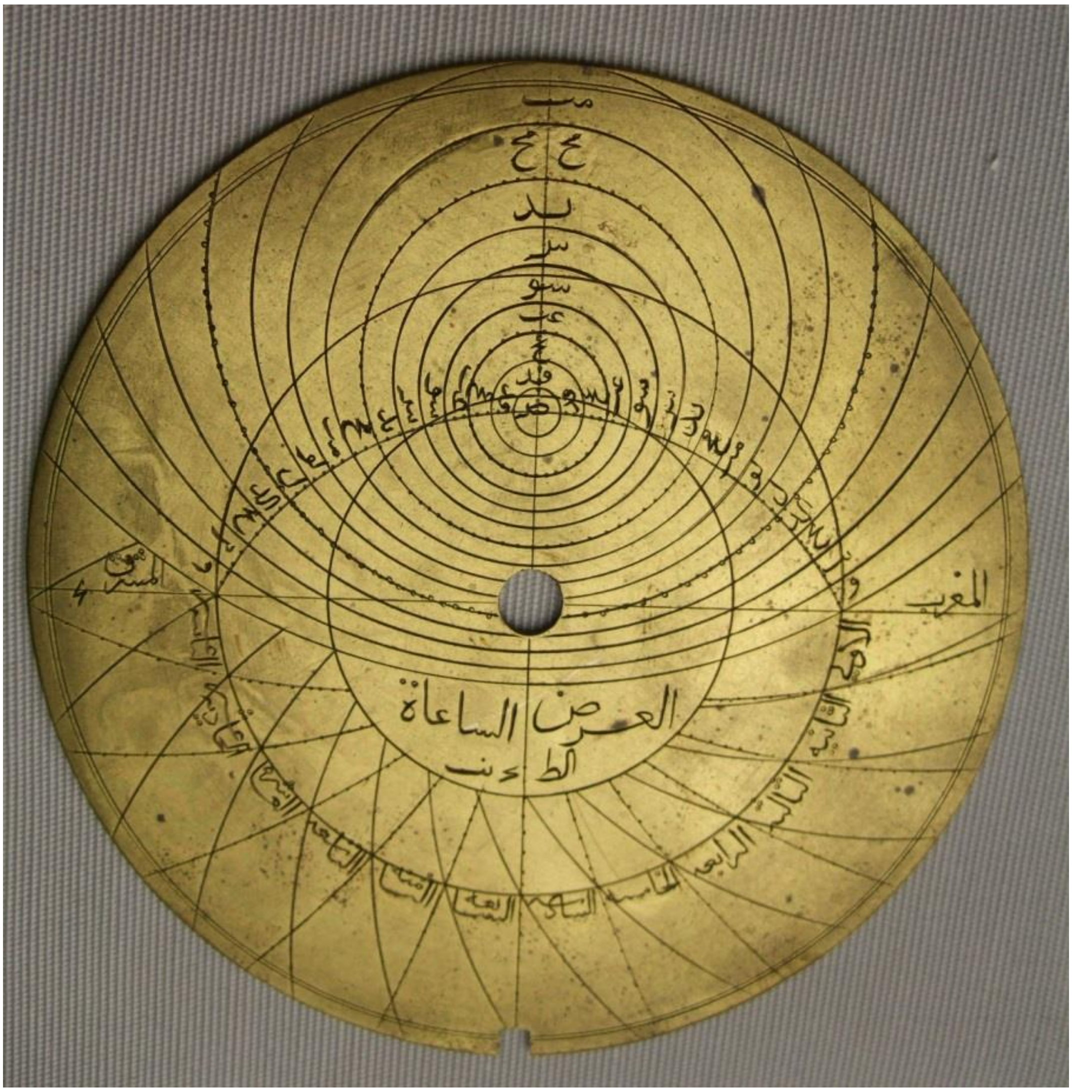

Figure A058.3 – Plate for latitude 29° (photo by Professor Jan Houben)

On plate 2b for latitude 34° altitude circles are drawn for every 6°; these are numbered on both sides of the meridian. Every fourth line (i.e. 24°) is highlighted by small circles and not with dots as is the usual case. Azimuth arcs are drawn above the horizon for every 10°; these are also numbered on both sides of the meridian. Every third line (i.e., 30°) is highlighted by dots. Interestingly, on the altitude circles for 24° and 48°, their points of intersection with azimuth arcs are marked with large X-like symbols.

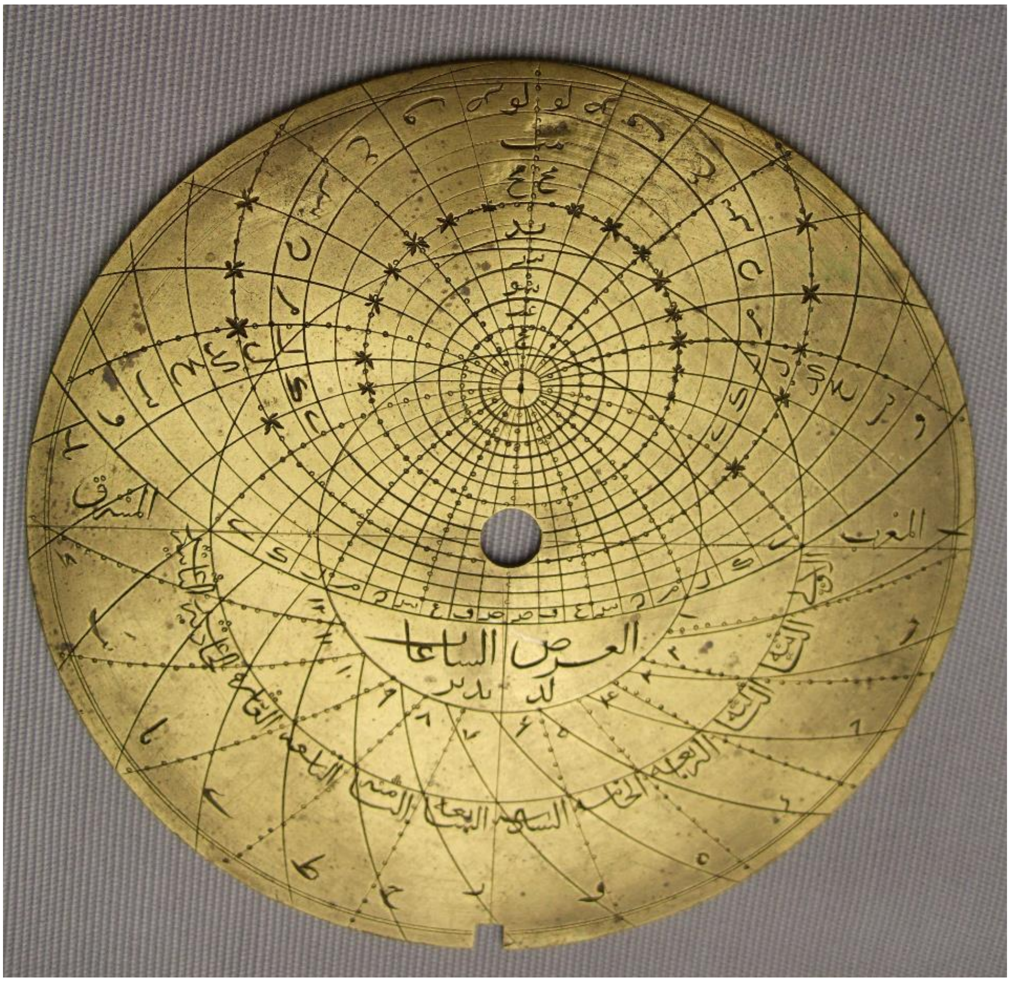

Figure A058.4 – Plate for latitude 34° (photo by Professor Jan Houben)

In the lower half are drawn dotted lines for seasonal hours and plain lines for equal hours from the western horizon. The seasonal hours are numbered from 1 to 12 in common Arabic/Persian numerals just below the circle of the Tropic of Cancer. The equal hours are numbered on the rim from 1 to 14 in *abjad* symbols. Finally, both kinds of hours are jointly numbered in ordinal numbers in Persian below the arc of the equator. On this plate, the small circles used in the place of dots on the lines as well as in words appear to have been punched with a die and not engraved by hand.

While 4a carries a combined projection of 0° and 90° as in many Lahore astrolabes, the reverse side 4b is engraved as the tablet of horizons, with the following four sets of half-horizons for latitudes from 12 to 66, which are numbered at both the extremities:

12	20	28	36	44	52	60
14	22	30	38	46	54	62

16	24	32	40	48	56	64
18	26	34	42	50	58	66

In addition, there is a full circle for the arctic latitude 72° (see also A054). But there are no declination scales.

Figure A058.5 – Geographical gazetteer (photo by Professor Jan Houben)

Geographical Gazetteer

The gazetteer provides the names, longitudes, latitudes, *inḥirāf* and *jahat* of 52 localities in two circles. In the outer circle, the five items are arranged in the sequence of *jahat*, place name, longitude, latitude and *inḥirāf*; in the inner row the sequence is

place name, longitude, latitude, *inḥirāf* and *jahat*. The last two parameters are not given for all places. Of the 52 localities, only three (Lahore, Multan and Agra) are in India proper.

Table A058-3 Geographical Gazetteer

	Place Name	L	φ	*inḥirāf*	*jahat*
	Outer circle				
1	Makka	77;10	21;40	0;0	
2	Madina	75;20	25;0	37;10	SE
3	Miṣr	63;20	30;20	—	—
4	Sana^{c}ā’	74;0	14;30	—	—
5	[A]l-Ḥasā	83;30	24;0	69	—
6	Bayt al-Maqdis	66;0	31;50	—	—
7	Dimashq	70;0	33;15	—	—
8	Ḥalab	72;10	35;50	80;35	SE
9	Mawṣil	77;0	34;30	—	—
10	Nakhjewān	81;15	38;40	—	—
11	Marāghah	82	37;20	16;11	SW (*gh-j*)
12	Tabrīz	82;0	38;0	15;46	SW
13	Ardabil	82;30	38;0	17;4	SW
14	Sarmar Rāī[350]	79	34;0	4;16	SW
15	Amul	88;20	36;5	35;1	SW
16	Kūfa	79;30	31;30	—	—
17	Baghdād	80;0	33;25	??	SW

350 Correct form is Sarman Rāī, i.e., Samurra

	Place Name	L	φ	*inḥirāf*	*jahat*
18	Baṣra	84;0	30;0	16;5	
19	Shustar	84;30	31;30	—	—
20	Kāzirun	87;0	29;15	11;14	SW
21	Shīrāz	88;0	29;0	?;8	SW
22	Yazd	89	32	43;29	SW
23	Hamadān	83;0	35;10	32;16	SW
24	Qazwīn	85;0	36;0	37;34	SW
25	Jurbādaqān	85;30	34;14	2?	SW
26	Iṣfahān	86;40	32;25	40;21	SW
27	Kāshān	86;0	34;0	34;31	SW
28	Qumm	85;40	34;45	31;15	SW
29	Tāliqān	85;45	36;10	—	SW
30	Astarābād	89;35	36;50	38;48	SW
31	Samnān	88;0	36;0	36;17	SW
32	Harāt	94;20	34;20	54;8	SW
33	Tūn	92;30	34;30	45;6	SW
34	Tūs	92;30	37;0	45;6	SW
35	Nishābūr	92;30	36;21	—	SW
	Inner Circle				
36	Sabzewār	92;30	36;0	?	SW
37	Bistām	89;30	36;10	39;8	SW
38	Zūzan	93;30	34;20	—	—
39	Lahāwar	109;20	31;50	—	—
40	Multān	107;35	29;40	—	—

	Place Name	L	φ	*inḥirāf*	*jahat*
41	Qandahar	104;40	33;0	75;5	SW
42	Samarqand	99;36	39;37	—	—
43	Bukhārā	97;20	39;50	—	—
44	Badakhshān	104;24	37;10	—	—
45	Akra	114	27;13	—	—
46	Kābul	104;40	34;26	—	—
47	Marw	97;0	37;40	52;30	SW
48	Bulghār ?	115	52	—	—
49	Chīn	140	22		
50	[Dhākā] Bankālā	135	23		
51	Istanbūl	?	43		
52	Balkh	105	36		

Figure A058.6 – Back of the astrolabe (photo by Professor Jan Houben)

BACK

The rim of the two upper quadrants carries altitude scales which are divided in 1° and 5° and numbered as 5, 10, 5, 20 … 5, 90; 90, 5, … 20, 5, 10, 5.

In the upper left quadrant are traced 30 equidistant horizontal parallels with every fifth highlighted with dots. Upon these are plotted five curves of unequal hours; these are numbered serially from 1 to 6. In the upper right quadrant, 7 declination arcs are drawn at unequal intervals and the related zodiac signs are marked by their serial numbers along the two radii.

In the lower half, close to the centre are two shadow squares; on the left for 7 feet and on the right for 12 digits. The scales are divided and numbered accordingly. The labels are abridged: the vertical scale on the left is labelled as *ẓill aqdām* and that on the right as *ẓill aṣābi*ᶜ. Two horizontal scales are labelled simply as *mustawī.*

The rim of the lower half carries the cotangent scales. The unequal divisions in the scale on the left are numbered from the meridian onwards as 5, 10, 15, 25, 30, 35; these are followed by the label *ẓill aqdām.* The unequal divisions in the scale on the right are numbered from the meridian onwards as 5, 10, 15, 25, 30, 35, 40, 45, followed by the label *ẓill aṣābi*ᶜ. Each of these divisions is subdivided into four units in the adjacent semi-circular row.

Inside the cotangent scales are five semi-circular rows. Each one is labelled on the left as well as on the right. The first row, counting from the outside, contains the names of the planetary lords of the limits, indicated by the last letters of their Arabic names, with the label *al-kawākib* (the planets). The second row provides the strengths of the limits with the *abjad* symbols, with the label *al-ḥudūd* (the limits). In the third row are engraved the names of the zodiac signs in large bold letters; here the label reads *al-burūj* (the signs). In the fourth row are engraved the names of the planetary lords of the decans / faces, three for each sign, with the label *al-wujūh* (the faces). In the fifth and the last row are the names of the 28 lunar mansions with the labels *al-manāzil* (the lunar mansions).

Finally, inside the shadow squares is engraved the table of triplicities, divided according to the four elements, and their nocturnal regents.

ALIDADE ETC

The alidade has ornate ends, but the centre-piece is plain and there are no graduations on the alidade. The pin has a large spherical head. The long wedge has a slit running along the entire length; it must have been taken from some other instrument

and used here as the wedge. The rule in the front does not have any graduations: it may not be original.

Figure A058.7 – Signature on the back (detail from Figure A058.6

INSCRIPTION

The maker's name is engraved inside a triangular arch-like border, above the innermost semicircle and below the shadow squares and reads

ᶜamal al-ᶜabd muḥammad muqīm

'The work of the servant Muḥammad Muqīm'

BIBLIOGRAPHY

Crommelin 1948.

ḌIYĀ’ AL-DĪN MUḤAMMAD

The instrument production in the Lahore family reached its culmination, both in quantity and quality, in the oeuvre of Ḍiyā’ al-Dīn Muḥammad (*fl.* 1637-1680) of the fourth generation. He is the most prolific and versatile member of the family. He inherited his father Qā'im Muḥammad’s skill in casting celestial globes and his uncle Muqīm’s virtuosity in crafting astrolabes. He also attempted a number of unusual varieties of astrolabes and globes. There are extant 34 astrolabes which bear his signature; another 12 astrolabes can be attributed to him on stylistic grounds.[351] Moreover, he also produced some 18 celestial globes.

On a majority of his instruments, he signs his name as ضياؤالدين , but in a few cases he writes without *wāw* (و) ضياءالدين , as shown in the table below. The name ‘Ḍiyā’ al-Dīn’ means ‘the light of the faith’ in Arabic and this name is fairly common among Muslims. But it is never written with a *wāw* in between. Scholars of Arabic and Persian whom I consulted are unanimous in saying that the letter *wāw* (و) here is not in accordance with the Indo-Persian or Persian usage and that it should not have been added in this name. From his vast and varied oeuvre, it is evident that Ḍiyā’ al-Dīn was not a mere artisan, but a scholar well-versed in mathematical astronomy and well-acquainted with Arabic works on astronomical instruments by the Andalusian astronomers. Why then did he spell his name in this manner in most of his creations remains a mystery.[352]

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351 CCA attributes the following four astrolabes to Ḍiyā’ al-Dīn, but these are not mentioned in the Répertoire; therefore, they are not included in our catalogue:

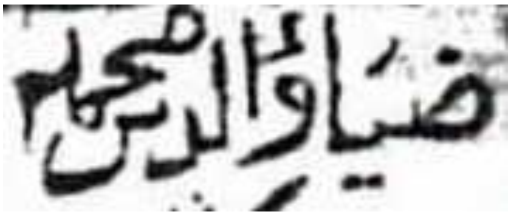
CCA 3524	nd	d. ?	Paris Landau Collection
CCA 3525	nd	d. ?	Paris Landau Collection
CCA 3517	nd	d. ?	Paris Alain Brieux
CCA 2829	1068/1657	d. ?	‘Cairo, Hariri Collection (Instruments now thought to be in Cairo, Museum of Islamic Art)’; but I was informed that the Cairo museum does not have such an astrolabe.

352 It is also a mystery why the knowledgeable Répertoire refers to him as ‘Muḥammad b. Qā’im Muḥammad’ in the heading to the section dealing with his instruments and dismisses ‘Ḍiyā’ ud-Dīn’ as the surname!

Astrolabe A061 of 1057/1647-48
Chicago

Astrolabe A062 of 1059/1649-50
Lucknow

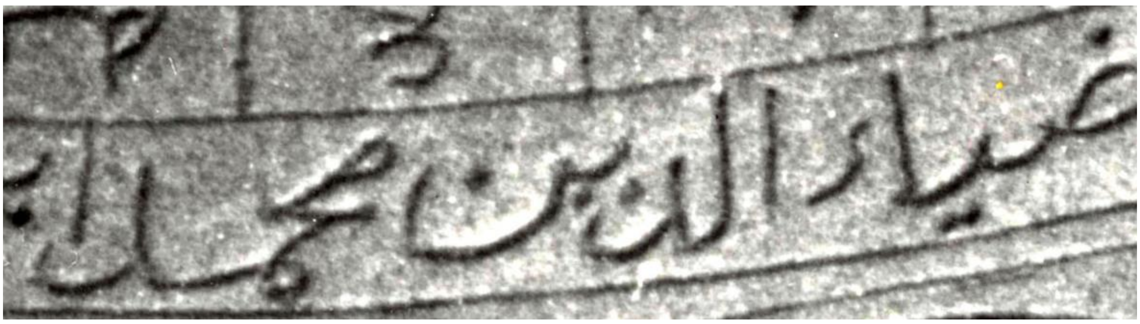
Celestial Globe of 1064/1653-54
Aligarh



Astrolabe A076 of 1070/1659-60
Washington

Celestial Globe of 1074/1663-64
Hyderabad

Astrolabe A072 of 1067/1656-57
Jaipur, without wāw



Zarqālī astrolabe A091 of 1091/1680-81, Jaipur, without wāw

Ḍiyā’ al-Dīn’s astrolabes range from 52 to 555 mm in diameter. Like Muqīm, he also made several miniature astrolabes with diameters measuring less than 100 mm. Muqīm’s astrolabe with a diameter of 45 mm is the world’s smallest (A050), but many of its original components are missing, whereas Ḍiyā’ al-Dīn’s astrolabe of 1064/1653-54 (A071) with its diameter of 65.5 mm is fully intact. The delicately crafted miniature astrolabe has a jewel-like quality.

The *kursīs* in Ḍiyā’ al-Dīn’s astrolabes are mostly reticulated and their surface is engraved with decorative patterns. He incorporates large flowers in the *kursīs* as well as in the traceries of the retes. Some of the floral compositions with large flowers and leaves in the retes (e.g. A070, A072, A074, A075, A091 and A094) recall similar floral arrangements in *pietra dura* style in Mughal monuments.

Ḍiyā’ al-Dīn’s geographical gazetteers generally commence with Mecca or Medina and reach up to India. But in 8 astrolabes, the gazetteers are arranged according to climates of antiquity (*iqlīm*) (e.g. A073, A074, A088 and others). In three astrolabes, the gazetteers are arranged according to regions (also called *iqlīm*) from the Maghreb in the west up to Hind in the east (A062, A072 and A093). Apparently Ḍiyā’ al-Dīn is the only one to arrange the gazetteers in this fashion.

Like Muqīm, Ḍiyā’ also draws two graphs for the midday altitude of the sun throughout the year for the latitudes of Agra (27°) and Lahore (32°) on the back of several astrolabes. After Shāh Jahān shifted the Mughal capital from Agra to Delhi in 1639, Ḍiyā’ began to add a third graph for the latitude of Delhi (29°). In A097, there is a fourth graph for 36° (middle of the fourth climate, i.e., the middle of the inhabited world). A095 and A101 have 2 more graphs for latitudes 21° (Mecca) and 24° (Tropic of Cancer). A067 of 1062/1651-52 displays 8 graphs for latitudes 15°, 19°, 21°, 27°, 29°, 32°, 35° and 40°. The highest number of curves to be found in the Lahore astrolabes are in A096 for 9 latitudes, viz., 19°, 27°, 32°, 36°, 40°, 44°, 49°, 56° and 60°.

As in Muqīm’s astrolabes, in Ḍiyā’ al-Dīn’s astrolabes also, the number of astrological tables engraved on the back vary according to the size of the astrolabe. Smaller astrolabes carry just two semi-circular rows engraved with the names of the 12 signs and the names of 28 lunar mansions. On larger astrolabes, there are also tables of the limits, faces, triplicities and excess of revolution.

Three astrolabes contain a table which is not found in other Lahore astrolabes. This table is called *zadwal sā^{c}āt ṭulū^c burūj bi-^{c}arḍ ba^{c}ḍī az bilād mulk al-Hind* (table of the times of rising of signs in the latitudes of some of the localities belonging to the country of India). While A072 provides the rising times of the signs at each degree of latitude from 20° to 39°,[353] A092 has a table from 20° to 40° and A093 from 21° to 40°.

In astrolabe A101, the upper right quadrant is designed as a solar quadrant as well as a universal horary quadrant. As a solar quadrant, it carries declination arcs for every 10° of solar longitude and 6 sigmoid curves to show the midday altitude of the sun throughout the year at 6 different latitudes. As a universal horary quadrant, it bears dotted arcs of unequal hours, numbered from 1 to 6 in the anticlockwise direction and from 7 to 12 in the reverse direction.

The lower half on back of the astrolabe A098 is designed in an extraordinary manner. The shadow squares, usually engraved in the lower half, are superimposed on the trigonometric and solar quadrants in the upper half. The lower half is engraved as the left half of a plate for latitude 27° with the altitude circles for each 6° and with lines for equal hours before sunrise. Moreover, the ecliptic circle is drawn along with the names of the 6 signs from *al-Saraṭān* to *al-Qaws.* These projections are framed by a degree scale, divided in 2° and 10° and labelled in 10s, from 90 to 10 (from the south point to the east point) and again from 10 to 90 (from the east point to the north point). With this configuration, the standard operations can be performed by means of the alidade as is done on an astrolabe quadrant.

Zawraqī Horizons

We have seen that Qā’im Muḥammad incorporates *zawraqī* or ‘ship’ horizons for the first time in two of his astrolabes. Ḍiyā’ al-Dīn adds them in 7 astrolabes in two different styles. In astrolabes A082 and A093, two small horizons for latitudes 29° and 32° are inserted in the rete in such a manner that they form a fish-like figure inside the ecliptic ring. A special plate is designed to be used with these horizons, on which astrological houses, divided into 5 units of 6°, are drawn for the two latitudes and a

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[353] This table is reproduced in Kaye 1918, p. 23.

miniature plate is created inside the circle of Cancer where the two small horizons on the rete fit. The positions of several stars are marked on this miniature plate with dots enclosed in small circles. A073 also follows the same style, but with just a single horizon for latitude 32°.

In the second style, the horizons are large and stretch over the whole width of the rete up the Capricorn ring on both sides. The plates to be used with the horizons do not carry miniature plates inside the circle of Cancer, but the entire plates are filled with star positions and astrological houses. Thus in A100, there are two *zawraqī* horizons for latitudes 29° and 32° and the two plates calibrated for 29° and for 32° are engraved with astrological houses as well as star positions. There are slight variations in this style. In A099, two *zawraqī* horizons for 29° and 32° are added to the rete; on the plate face calibrated for 29°, the positions of all those stars are marked which are in the rete; on another plate face, astrological houses are marked for both these latitudes 29° and 32°. In astrolabe A101, there is just one *zawraqī* horizon on the rete for latitude 24° and the plate face for 24° is marked with star positions and astrological houses. In another variation, in A102, there is an extra rete carrying just two *zawraqī* horizons for latitudes 37° and 38°, but without any corresponding plates for these latitudes.

North-South Astrolabes

Three astrolabes are designed as north-south astrolabes (*asṭurlāb shamālī wa janūbī*). In A090, the obverse side of the single plate is engraved as a latitude plate for 33° and on it is superimposed a northern projection of the ecliptic circle together with the positions of 46 stars, while the reverse side is designed for latitude 35° on which a southern projection of the ecliptic circle is drawn and the positions of the same 46 stars, but with southern orientation, are marked. The choice of these latitudes is rather intriguing. There is a minimal rete consisting of just the ecliptic ring and an alidade with a sighting tube.

Astrolabe A103 also consists of a single plate on which the two sides carry respectively the northern and southern projections of the ecliptic and of some star positions. However, the obverse side is engraved with a double projection for two latitudes 32° and 36° and the reverse with a quadruple projection for latitudes 22°, 25°, 27° and 29°.

Astrolabe A104 is much more complex with two separate retes, one with a northern projection and another with a southern projection, and with plates carrying either northern projections, or southern projections, or both.

Zarqālī Universal astrolabe

The crowing glory of Ḍiyā’ al-Dīn’s work is the monumental *Zarqālī* astrolabe he made in 1681 with a diameter of 555 mm. It consists of a single plate which can be used at all latitudes. It was originally designed by Ibn al-Zarqalluh at Toledo in the eleventh century. There are not many Zarqālī astrolabes extant today and none of these is comparable to the magnificent creation of Ḍiyā’ al-Dīn Muḥammad.

A059⊙ ASTROLABE BY ḌIYĀ AL-DĪN MUḤAMMAD, 1047 AH (AD 1637-38) [354]

Diameter 117 mm

Chicago, Adler Planetarium & Astronomy Museum (# A-86)

CCA 2558; Répertoire 4

Figure A059.1 – Front of the astrolabe (accession no. A-86). Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

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[354] Entry based on Pingree 2009, No. 15, pp. 64-68; the star list has been rearranged according to increasing right ascensions.

This is the earliest known astrolabe made by Ḍiyā’ al-Dīn Muḥammad. Following his uncle Muḥammad Muqīm, Ḍiyā’ al-Dīn calibrates the two sides of a plate for the latitudes of 27° and 32° respectively and draws, on the upper right quadrant on the back, two sigmoid curves of the solar meridian altitudes for the same two latitudes, these being the latitudes of Agra and Lahore, the two Mughal imperial cities.

COMPONENTS

Body with *kursī* (d. 117, h. 142, t. 8), shackle and ring, rete for 27 stars, 4 plates, alidade, pin and horse. Body and rete of brass; alidade, pin and horse of a darker alloy; plates of copper.

FRONT

From the photo it is not clear whether the shackle has a trefoil form and whether there is a trifoliate finial on the *kursī.* The *kursī* has lobed profiles and a simple but symmetric fretwork. The limb is divided in 1° and 6°. Dotted lines mark the boundaries of 3° and 6° and plain lines those of 1°. Labelled in 6s from 6 to 360.

RETE

The two circles of the Tropic of Capricorn and ecliptic are held together by an equinoctial bar which has two counter changes on either side of the centre about the middle of the centre and the ecliptic ring. This is somewhat unusual; unusual are also the 27 star pointers having the shape of vultures perched on a tree. These star pointers generally emanate from the two rings and from the equinoctial bar. Four pointers however arise from an upside down arch in the lower half. There is a handle on the Capricorn ring at the north point. The 27 stars marked on the rete are as follows:

Table A059-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab Qayṭus*	β Ceti[355]

355 Pingree identifies it as ι Cet, but the star is placed clearly in Aries; therefore, it is the southern counterpart, viz. *Dhanab Qayṭus Janūbī.*

	Star Name	Identification
2	*Ṣadr*	π Ceti
3	*Ghūl*	β Persei
4	*Masāfat al-Nahr*	γ Eridani
5	*ᶜAyn al-Thawr*	α Tauri
6	*ᶜAyyūq*	α Aurigae
7	*Rijl al-Yusrā*	β Orionis
8	*Yad Yumnā*	α Orionis
9	*Shiᶜrā Yamānī*	a Canis Minoris
10	*[Shiᶜrā] Shāmī*	α Canis Majoris
11	*Fard al-Shujāᶜ*	α Hydrae
12	*Ẓahr al-Dubb*	α Ursae Majoris
13	*Qāᶜidat*	α Crateris
14	*Janāḥ al-Ghurāb*	γ Corvi
15	*Simāk Aᶜzal*	α Virginis
16	*Simāk Rāmiḥ*	α Bootis
17	*Nayyir Fakka*	α Coronae Borealis
18	*ᶜUnuq al-Ḥayya*	α Serpentis
19	*Qalb al-ᶜAqrab*	α Scorpii
20	*Rās al-Ḥawwā'*	α Ophiuchi
21	*Nasr Wāqiᶜ*	α Lyrae
22	*Nasr Ṭā'ir*	α Aquilae
23	*Dhanab Dajāja*	α Cygni
24	*Fam al-Faras*	ε Pegasi
25	*Sāq Ayman*	δ Aquarii

	Star Name	Identification
26	*Mankib al-Faras*	β Pegasi
27	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are four plates with notches at the north point.

Table A059-2

	φ	Longest day
1a	27°	13;43 hours
1b	32°	14;8 hours
2a	30°	13;58 hours
2b	34°	14;12 hours
3a	36°	14;32 hours
3b	40°	14;54 hours
4a	Tablet of ecliptic coordinates	
4b	Tablet of horizons	

The first three plates carry altitude circles for every 6°, plain lines for seasonal hours and dotted lines for equal hours counted from the western horizon. The prime vertical is drawn as a plain line above the horizon and is dotted below the horizon. The azimuths are drawn for every 10°, but their location varies: on 1a, 2a, 2b, 3a they are drawn below the horizon; on 1b both above and below the horizon; on 3b only above the horizon.

On the tablet of ecliptic coordinates (4a), the arcs for the celestial longitudes are drawn at intervals of 10° and numbered as 10, 20, 30, separately for each zodiac sign. The circles of the celestial latitudes are drawn for every 6°. These are numbered from 6 to 90 to the north of the ecliptic up to the zenith and from 6 to 48 to the south up to

the Tropic of Capricorn. The names of the zodiac signs are inscribed partly outside the ecliptic circle and partly inside. Beneath the horizontal diameter is written *al-mashriq* in the east and *al-maghrib* in the west. Above the north point, there is label identifying the plate as *ṣafīḥat mīzān al-ᶜankabūt.*

The reverse side of this plate (4b) is engraved as the tablet of horizons with half-horizons drawn for the following latitudes:

4	14	24	34	44	54	64
6	16	26	36	46	56	66
8	18	28	38	48	58	
10	20	30	40	50	60	

Declination scales are drawn along the vertical and horizontal diameters and labelled 6, 12, 18, 24. The name of the plate is not engraved.

Figure A059.2 – Geographical gazetteer (accession no. A-86)
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

GEOGRAPHICAL GAZETTEER

On the inner side of the mater is engraved a gazetteer in two circles, providing the names, longitudes and latitudes, in this order, for 50 localities:

Table A059-3 Geographical Gazetteer

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-arḍ*
	Outer Circle		
1	Madīnat Rasūl	75;20	25;0
2	Makka Mubārak	77;10	21;40

	Place Name *al-bilād*	**L** *al-ṭūl*	**φ** *al-arḍ*
3	Ḥalab	72;10	35;50
4	Sumyāt	72;35	40;0
5	Arbīl	77;20	35;0
6	Kūfa	79;30	31;30
7	Baṣra	84;0	30;0
8	Shīrāz	88;0	29;36
9	Yazd	89;0	32;30
10	Iṣfahān	86;40	32;25
11	Qum	85;40	35;45
12	Rayy	86;20	35;0
13	Ṭūs	92;30	36;0
14	Samarqand	99;56	39;37
15	Hurmūz	92;0	25;0
16	Kābulistān	104;20	33;35
17	Tatta	102;7	25;10
18	Multān	107;35	29;40
19	Qandahār	107;40	33;0
20	Kashmīr	108;0	35;0
21	Tubbat	110;0	40;0
22	Lāhūr	109;20	31;50
23	Siyālkūt	109;10	33;0
24	Dimashq	70;0	33;15
25	Miṣr	63;20	30;20
26	Tabrīz	82;0	38;0

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-arḍ*
27	Madā’in	72;0	33;10
28	Baghdād	80;30	33;25
29	Balkh	101;0	36;41
30	Badakhshān	104;24	37;30
31	Bukhārā	97;30	39;50
	Inner Circle		
32	Sunām	114;0	30;30
33	Bānībatah	113;20	28;52
34	Tānīsar	112;26	30;10
35	Dihlī	113;35	28;20 !
36	Akra	114;0	27;13 !
37	Qannawj	116;50	26;36
38	Jawnbūr	119;6	26;36
39	Bānārasī	117;20	26;55
40	Ajmīr	111;5	25;0 !
41	Kawāliyār	115;0	26;29
42	Aḥmadābād	108;40	23;15
43	Kanbāyat	109;10	22;20
44	Ujjayn	102;0	22;30
45	Mandū	107;10	22;13
46	Burhānbūr	109;0	20;31

	Place Name *al-bilād*	**L** *al-ṭūl*	**φ** *al-arḍ*
47	Jidda[356]	76;0	21;0
48	Bījābūr	105;30	17;20
49	Dawlatābād	111;0	20;30
50	Aḥmadnakar	107;0	19;0

356 It is intriguing that Jeddah of Saudi Arabia is inserted here among the Indian towns in many astrolabes of Ḍiyā’ al-Dīn and also of Muqīm.

Figure A059.3 – Back of the astrolabe (from Pingree 2009)

BACK

The rim of the upper half carries the altitude scales which are graduated for 1° and 6°, and labelled as 6—90; 90—6. The rim of the lower half has the scales of cotangents.

In the upper left quadrant are drawn 30 horizontal parallels, with every third highlighted with dots, representing the cosines for every 2 of the 60 parts of the Radius.

In the upper right quadrant are declination arcs, the spaces between every two lines representing a pair of zodiac signs. The related signs are marked by their serial numbers from 0 to 11 along the two radii. Upon these arcs are drawn two curves for the midday altitude of the sun at the latitudes of 27° and 32°, accompanied by the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27°* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ* 32.

In the lower half, immediately below the horizontal diameter are the shadow squares, on the left for a base of 12 and on the right for a base of 7. The vertical and horizontal scales are divided, accordingly into 12 or 7 parts and numbered. Inside the squares, in the corner between the vertical and horizontal scales on the left is the label *ẓill sullam aṣābiᶜ,* and on the right *ẓill sullam aqdām.* Outside the squares are the following labels along the four scales:

Vertical scale on the left:	*ẓill aṣābiᶜ maᶜkūs*
Horizontal scale on the left:	*ẓill aṣābiᶜ mustawī*
Horizontal scale on the right:	*ẓill aqdām mustawī*
Vertical scale on the right:	*ẓill aqdām maᶜkūs*

Inside the shadow squares are two semi-circular rows in which the names of the 12 signs of the zodiac and those of the 28 lunar mansions are inscribed. In the space between these semi-circular scales and the horizontal diameter is the maker's inscription, written upside down (see below).

ALIDADE

The straight-bar alidade has ornate ends and an ornate centre-piece. The right hand side is divided in units matching the divisions in the upper left quadrant and numbered in 6s from 6 to 60. It also carries a scale for sundials. The left hand side is marked with arcs to match the declination arcs in the upper right quadrant along with the serial numbers of the pair of zodiac signs. The pin is original, but the wedge, made out of a bent piece of metal, is a replacement.

INSCRIPTION

ᶜamal ḍiyā' al-dīn muḥammad ibn qā'im muḥammad ibn mullā ᶜīsā
ibn mullā allāhdād asṭurlābī humāyūnī lāhūrī
fī sanah 1047 hijrī

> ‘The work of Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Mullā Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1047 Hijrī.’

PROVENANCE

Ali Kuli Khan; Adler purchase before 1945.

BIBLIOGRAPHY

Pingree 2009, no. 15, pp. 64-68.

A060 ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1056 AH (AD 1646-47)

Diameter 193 mm

PLU, ex-Paris, Collection Nicolas Landau

CCA 2600; Répertoire 2

Components

Body, rete for 47 stars, 6 plates

Back

Upper left quadrant carries a graph of sines; upper right quadrant has declination arcs with two sigmoid curves showing the midday altitude of the sun at the latitudes 27° and 32°.

Inscription

As recorded in the Répertoire:

> *ayn san^{c}at ḍiyā’ al-dīn muḥammad*
> *ibn qā’im muḥammad ibn ^{c}īsā ibn allāhdād*
> *asṭurlābī humāyūnī lāhūrī*
> *fī sanah 1054 hijrī gh-n-w*
> ‘This is the work of Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of ^{c}Īsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1054 Hijrī, [in *abjad* notation] 1000+50+4.’

Provenance

Ex-collection Nicolas Landau, Paris

Ex-Collection H. P. Locker, Würzburg

Bibliography

Catalogue Sotheby’s, 27 March 72, lot 79.

A061⊙ ASTROLABE BY ḌIYĀ AL-DĪN MUḤAMMAD 1057 AH (AD 1647-48)[357]

Diameter 121 mm

Chicago, Adler Planetarium & Astronomy Museum (#A-70)

CCA 1095; Répertoire 3

Figure A061.1 – Front of the astrolabe (accession no. A-70)
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

[357] Entry based on Pingree 2009, No. 16, pp. 69-72; the star list has been rearranged according to increasing right ascension.

The *kursī*, though of simple fretwork, is a great improvement on the previous astrolabe of 1637, with elegant profiles and exaggerated trifoliate finial. The rete shows, for the first time, a floral tracery joining the star pointers. In the inscription, all the three ancestors are given the title *mullā* (learned).

COMPONENTS

Body with *kursī* (d. 121, h. 170, t. 9), shackle and ring, rete for 33 stars, 4 plates, alidade and pin; the wedge is missing.

FRONT

The ring is large, the shackle probably of trefoil shape and the *kursī* elegant with profiles made up of ogees at the base and at the top with a lobe in between and with a trifoliate finial. The fretwork is simple but pleasing with the motif of a triangle in the middle below which the empty space is also of triangular shape.

The scale on the limb divided in 1° and 5°, and numbered from 5 to 360.

RETE

The two rings of Capricorn and ecliptic are held together by the equinoctial bar which has counter changes at its two intersections with the ecliptic ring. There is a large handle a little to the right of the north point. Its large spherical head matches with that of the pin.

The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names. Each sign is divided into 5 units of 6° each; the division lines are dotted. The units are numbered 6, 12, 18, 24, 30 separately in each sign.

The star pointers are joined by a symmetric floral tracery with the dominant motif of a three-petalled tulip in the middle of the ecliptic ring; the same motif is repeated right below under the ecliptic ring. On the either side of the meridian line, slender tulips with their two flared petals are placed almost symmetrically.

Table A061-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus al-Janūbī*	β Ceti

	Star Name	Identification
2	*Baṭn al-Ḥūt*	β Andromedae
3	*Rijl al-Musalsala*	γ Andromedae
4	*Fam al-Qayṭus*	γ Ceti
5	*Ṣadr al-Qayṭus*	π Ceti
6	*Tālī Masāfat al-Nahr*	γ Eridani
7	*ᶜAyn al-Thawr*	α Tauri
8	*ᶜĀyyūq*	α Aurigae
9	*Rijl al-Jawzā’ al-Yusrā*	β Orionis
10	*Yad al-Jawzā’ al-Yusrā*	γ Orionis
11	*Rijl al-Jawzā’ al-Yumnā*	κ Orionis
12	*Shiᶜrā Shāmī*	α Canis Minoris
13	*[Fa]rd al-Shujāᶜ*	α Hydrae
14	*Ẓahr al-Dubb al-Aᶜẓam*	α Ursae Majoris
15	*Qāᶜidat al-Bāṭiya*	α Crateris
16	*Al-ᶜAnāq*	ζ Ursae Majoris
17	*Janāḥ al-Ghurāb*	γ Corvi
18	*Al-Aᶜzal*	α Virginis
19	*Rāmiḥ*	α Bootis
20	*Kiffa Janūbī*	α Librae
21	*ᶜUnuq al-Ḥayya*	α Serpentis
22	*Rās al-Jāthī*	α Herculis
23	*ᶜAyn al-Tinnīn*	α Draconis
24	*Yad al-Ḥawwā’*	δ Ophiuchi
25	*Wāqiᶜ*	α Lyrae

	Star Name	Identification
26	*Nasr Ṭā'ir*	α Aquilae
27	*Dhanab al-Dulfīn*	ε Delphini
28	*Fam al-Faras* (?)	ε Pegasi
29	*Dhanab al-Jadī*	δ Capricorni
30	*Sāq Sākib al-Mā' Janūbī*	δ Aquarii
31	*Dhanab al-Qayṭus al-Shamālī*	ι Ceti
32	*Al-Faras*	β Pegasi
33	*Kaff al-Khaḍīb*	β Cassioperiae

PLATES

There are four plates, but the first two bear identical calibrations!

Table A061-2 Plates

	φ	Longest day
1a	27°	13;43 hours
1b	32°	14;8 hours
2a	27°	13;43 hours
2b	32°	14;8 hours
3a	36°	14;32 hours
3b	40°	14;58 hours
4a	Tablet of ecliptic coordinates	
4b	Tablet of horizons	

On plates 1-3, altitude circles are drawn for every 3°, each fifth line dotted; azimuth arcs are drawn for every 15° below the horizon and plain lines for seasonal hours and dotted lines for equal hours counted from the western horizon.

On the tablet of ecliptic coordinates, arcs of the celestial longitudes are drawn for every 10° and labelled as 10, 20, 30, separately for each zodiac sign. The circles of celestial latitudes are drawn for every 6° and numbered from the ecliptic northwards up to the zenith and southwards up to the Tropic of Capricorn. The names of the signs are written along the ecliptic circle, some inside the circle and others outside the circle. Just above the north point is the label *ṣafīhat mīzān al-ᶜankabūt.*

On the tablet of horizons, half horizons are drawn for the following latitudes:

4	12	20	…	60
6	14	22	…	62
8	16	24	…	64
10	18	26	…	66

Declination scales are engraved along the vertical and horizontal diameters and labelled as 6, 12, 18, 23;30, where 23;30 indicates the maximum obliquity. There is no label on this side of the plate.

Geographical Gazetteer

The gazetteer is engraved in two circles, each separated by a blank circle, with the place names, longitudes and latitudes for 58 localities beginning with the holy city of Mecca.

Table A061-3 Geographical Gazetteer

	Place Name *asmā' al-buldān*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
	Outer Circle		
1	Makka Muᶜaẓẓam	77;10	21;40
2	Madīnat Musharrafa	75;20	25;0

	Place Name *asmā' al-buldān*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
3	Mahadiyya Maghrib	42;0	32;30
4	Iskandariyya	61;57	30;18
5	Miṣr	63;20	30;20
6	Āmid	73;40	33;0
7	Marāgha	82;0	36;20
8	Tabrīz	82;0	38;0
9	Ardabīl	82;30	38;0
10	Bulghār	90;0	49;30
11	Kūfa	79;30	31;30
12	Madā'in	72;0	33;10
13	Baghdād	80;30	33;25
14	Baṣra	84;0	30;0
15	Iṣfahān	85;0	34;45
16	Sabzawār	91;30	36;5
17	Nīshābūr	92;30	36;21
18	Ṭūs	94;30	37;0
19	Harāt	94;33	34;30
20	Balkh	101;0	36;41
21	Badakhshān	104;24	37;10
22	Bukhārā	97;30	39;50
23	Samarqand	99;56	39;37
24	Kāshghar	106;30	44;0
25	Hurmūz	92;0	25;0

	Place Name *asmā’ al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*
26	Aḥmadābād	108;40	23;15
27	Ujjayn	112;0	22;30
28	Amarkūt	105;0	25;0
29	Kābul	104;40	34;30
30	Mīwāt	117;10	34;50
31	Barāwan[358]	117;59	27;32
32	Hansī	102;25	29;15
33	Tānīsar	112;33	30;10
34	Pānīpatah	113;20	28;52
35	Dihlī	113;35	28;20 !
	Inner Circle		
36	Ajmīr	111;5	24;0 !
37	Kawāliyār	114;0	26;29
38	Kashmīr	108;0	35;0
39	Tubbat	110;0	40;0
40	Sarandīp	130;0	10;0
41	Bānārasī	117;20	26;50
42	Qannawj	115;50	26;50
43	Lahāwar	109;20	31;50
44	Qandahār	107;40	33;0
45	Mūltān	107;35	29;40

[358] Error for Badā’ūn.

	Place Name *asmā’ al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*	
46	Sanbhal	115;0	28;10	
47	Kara	117;6	26;16	
48	Chanpānīr	108;45	22;30	
49	Kambāyat	109;10	22;20	
50	Jidda	76;0	21;0	
51	Bījābūr	105;30	17;20	
52	Dawlatābād	111;0	20;30	
53	Burhānpūr	109;0	20;31	
54	Jawnpūr	119;6	26;36	
55	Mānikpūr	118;10	26;49	
56	Awadh	118;6	27;22	
57	Darband Jīn	178;40	23;0	Canton, China
58	Pūruswar	115;15	31;10	

BACK

The rim of the upper half bears the altitude scales which are divided in 1° and 5° and labelled as 5—90; 90—5. The rim of the lower half has the scale of cotangents.

In the upper left quadrant are drawn 30 horizontal parallels, i.e., cosines for every 2 of the 60 parts of the Radius, with every fifth line dotted.

In the upper right quadrant are drawn five dotted declination arcs so that each of the six intermediary spaces represents a pair of zodiac signs. The latter are marked by their serial numbers (0 to 11) along the two radii. Upon these arcs of declination are plotted two graphs of the solar altitude at midday for the latitudes 27° and 32°, with the labels *khaṭṭ niṣf al-nahār ᶜarḍ 27°* and *khaṭṭ niṣf al-nahār ᶜarḍ 32°*.

In the lower half are two shadow squares, on the left for 7 feet and on the right for 12 digits with their scales divided accordingly in 7 or 12 parts. The labels are:

Vertical scale on the left	*ẓill aqdām ma*ᶜ*kūs*
Horizontal scale on the left	*ẓill aqdām mustawī*
Horizontal scale on the right	*ẓill aṣābi*ᶜ *mustawī*
Vertical scale on the right	*ẓill aṣābi*ᶜ *ma*ᶜ*kūs*

Inside the shadow squares are two semi-circular rows in which are inscribed the names of the 12 zodiac signs and those of the 28 lunar mansions.

Figure A061.2 – Back of the astrolabe (accession no. A-70)
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

ALIDADE

The alidade has plain ends and a plain centre piece. The rim is divided in 31 divisions, each division halved and also subdivided into 5 units. The divisions are numbered in the most peculiar manner. On the left 40, 17, 17, 21, 40, 14, 10, 3, 43, 5, 9, 20, 27, 40, 14; similar jumble of *abjad* symbols on the right as well. The alidade is clearly a replacement, made by a person who did not understand its function.

INSCRIPTION

In the space between the horizontal diameter and the semi-circular rows is engraved the maker’s inscription:

> *ᶜamal ḍiyā’ al-dīn muḥammad ibn mullā qā’im muḥammad ibn mullā*
> *ᶜīsā ibn mullā allāhdād asṭurlābī humāyūnī lāhūrī*
> *sanah 1057 hijrī.*
>
> ‘The work of Ḍiyā’ al-Dīn Muḥammad, son of Mullā Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Mullā Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, [in] the year 1057 Hijrī.’

PROVENANCE

E. S. David 1940; purchased by Adler in 1940.

BIBLIOGRAPHY

Pingree 2009, no. 16, pp. 69-72.

A062⊙ ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1059 AH (AD 1649-50)

Diameter 185 mm

Lucknow, Darul Uloom Nadwatul Ulama

CCA 1126; Répertoire 7

Figure A062.1 – Front of the Astrolabe (photo by S. R. Sarma)

This exquisitely crafted astrolabe is one of the masterpieces produced by Ḍiyā’ al-Dīn.

COMPONENTS

Body with *kursī* (d. 185, h. 261, t. 9), shackle and ring, rete (d. 161) for ca. 40 stars, 5 plates (d. 161), alidade (165 x 13 x 3) with a sighting tube; the pin, nut, and washer are not original but added later.

Figure A062.2 – The *kursī* of the Astrolabe (photo by Dr Owen Cornwall)

FRONT

The ring has a diamond cross-section; the shackle also has a diamond cross-section and a trifoliate shape. The outlines of the *kursī* (ogees rising from the body on either side, followed by a lobe and another ogee and a trifoliate finial) are generally the same as in many other astrolabes by Ḍiyā’ al-Dīn, but the fretwork here is the most intricate and the surface engravings are most impressive; there is no doubt that this one of the most beautiful *kursīs* fashioned by the hand of this astrolabe maker. The limb is divided in 1° and 5° and labelled from 5 to 360.

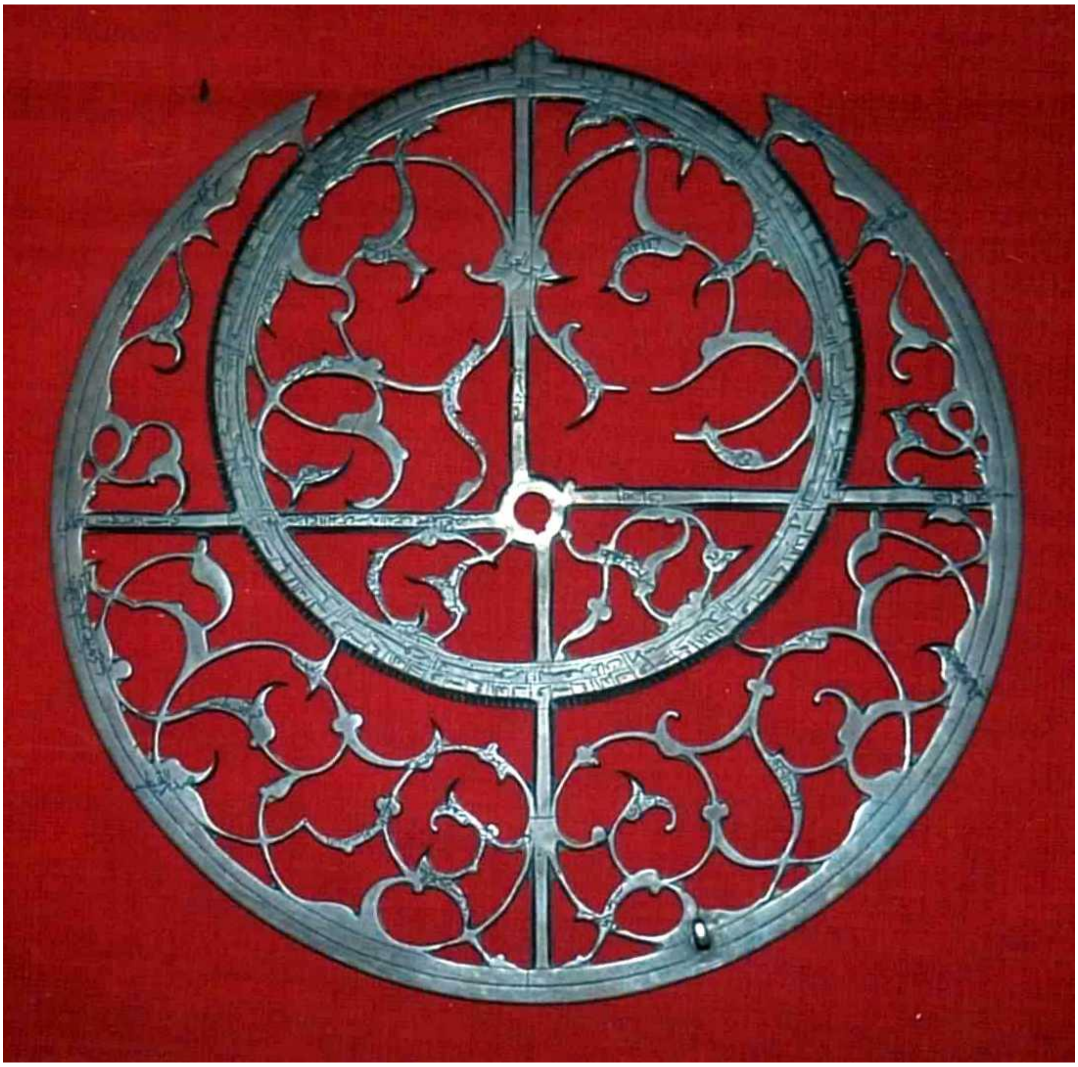

Figure A062.3 – The rete of the astrolabe (photo by S. R. Sarma)

RETE

The two rings of the Tropic of Capricorn and ecliptic are held together by the equinoctial as well as solstitial bars, both completely represented, and both with a counter-change at the centre. The spaces inside these circles are filled with an almost symmetrical pattern of vines making spirals and circles. From the vines arise a number of tulip flowers with flared petals, one or both tips of these petals forming named star pointers. However, the star names are engraved in such tiny characters that it is hardly possible to decipher the star names, although one could, of course, guess them from their positions. In the upper left quadrant, close to the apex, there is a break in one or two vines.

The ecliptic circle is divided into the 12 zodiac signs and labelled with their names. Each sign is subdivided into units of 6° and these units are numbered 6, 12 … 30. On

the sloping edge of the ecliptic circle, these units of 6° are further subdivided into units of 2°.

There is a rectangular handle on the circumferential band a little to the right of the north point.

PLATES

There are five plates with the following functions:

Table A062-1 Plates

	φ	Longest day
1a	22°	13;21 hours
1b	25°	13;25 hours
2a	27°	13;43 hours
2b	32°	14;8 hours
3a	34°	14;22 hours
3b	36°	14;30 hours
4a	38°	14;40 hours
4b	40°	14;50 hours
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

On plates 1 to 4, altitude lines are drawn for every 2° with each fifth circle dotted; azimuth lines for every 6° below the horizon with each fifth dotted and extended above the horizon. Seasonal hours are indicated by plain lines. Dotted lines for equal hours are drawn from the western horizon on all plates except 1a where they are drawn from both the western and eastern horizons. All the lines are numbered.

On plate 5a, which carries a label designating it as *ṣafīḥat mīzān al-ᶜankabūt,* the arcs of celestial longitudes are drawn for every 6° and every fifth (30°) which marks the boundary between two successive zodiac signs is dotted. Along the ecliptic circle

the names of the signs are engraved and also the numerical values of the subdivisions of the signs. The circles of the celestial latitudes are drawn for every 3°.

Figure A062.4 – Tablet of horizons (photo by Owen Cornwall)

Plate 5b carries the tablet of horizons with the label *ṣafīḥa āfāqī.* Here are drawn four sets of half-horizons for every degree of latitude from 4° to 66;30°. These are distributed in the following manner:

3	7	11	…	55	59	63
4	8	12	…	56	60	64
5	9	13	…	57	61	65
6	10	14	…	58	62	66;30

These horizons are numbered at both the ends. The horizons which lie inside the equator are labelled as *afāq sharqī* (eastern horizons) under each one of the four sets.

Along the vertical and horizontal diameters, declination scales are incorporated between the equator and the tropics. These are divided in 2° each and labelled in 6s as 6, 12, 18, 23;30. The scales which are between the equator and the Tropic of Cancer, i.e., to the north of the equator, carry labels *taqsīm mayl kullī shamālī* (degrees of the maximum declination north) and those situated between the equator and the Tropic of Capricorn, i.e., to the south of the equator have labels stating *taqsīm mayl kullī janūbī* (degrees of maximum declination south).

Figure A062.5 – Geographical gazetteer, the upper section (photo by S. R. Sarma)

GEOGRAPHICAL GAZETTEER

On the inner side of the mater is engraved a geographical gazetteer in four circles, providing the names, longitudes and latitudes of 120 localities. The localities are arranged according to regions from Maghreb in the west up to Hind in east; but in Hind just two localities, Agra and Delhi, are mentioned! The data is inscribed in a zigzag manner and the spaces between the four circles are filled with the names of the regions. Thus the engraving is densely cluttered and quite difficult to read.

Ḍiyā’ al-Dīn arranged the gazetteer according to regions in two other astrolabes both larger than this; A072 of 1067/1656 with a diameter of 312 mm carries a gazetteer

of 210 localities; the other astrolabe (A093), made some time after 1648 with a diameter of 526 mm accommodates a gazetteer of 259 localities.

These gazetteers are based Ulugh Beg’s geographical tables.[359] But in these astrolabe gazetteers, the headings containing the names of the regions are not correctly engraved. In the table below, the headings will be reproduced as in the astrolabe; variations from Ulugh Beg’s tables will be noticed in footnotes. The identification or modern names of the localities listed here will be provided in the description of astrolabe A070.

Table A062-2 Geographical Gazettee

	Place Name	L	φ
	First Circle		
Iqlīmhā Maghrib (the region of Maghreb)			
1	Sūs Āqṣā	15;32	32;0
2	Fars Qaṣba Ṭanja[360]	18;0	22;0
3	Tāhart ʿUliyā’	30;30	19;0
4	Tāhart Suflis	36;0	31;30
5	Siljāsa	37;0	31;30
6	Qīzān	48?;0	31;40
7	Mahadiyya Maghrib	42;0	32;30
8	Ṭarābulus	45;0	32;0
Andalus (Andalusia)			
9	Qurṭaba dar al-Mulk Andalus	38;26	35;0

[359] Cf. Sédillot 1853, pp. 257-271.

[360] The correct name is ‘Fas’ (modern Fez); Ulugh Beg gives the latitude as 32;0° which is the correct value.

	Place Name	L	φ
10	Bajja az Barbar[361]	65;0	14;0
Sūdān (Sudan)			
11	Jarmī Dar al-Mulk Habasha	65;0	9;30
12	Darqala	53;60	14;30
Miṣr (Eqypt)			
13	Qūs az Qaṣba Miṣr	61;30	24;30
14	Iskandariyya	61;54	30;18
15	Miṣr	63;20	30;20
16	Dumyāṭ	63;30	31;25
Yaman (Yemen)			
17	Qulzum az Kanār Darya[362]	64;0	29;30
18	ᶜAdan	76;0	11;0
19	Sanᶜā’ Dār al-Mulk Yaman	77;0	14;30
ᶜUmān (Oman)			
20	Zabīd	74;20	14;10
21	Ṣajā Qaṣba ᶜUmān	84;0	14;20
Ḥijāz (Hejaz)			
22	Madīnat Rasūl ᶜAlayhi al-Salām	74;20	25;0
23	Makka Mubārak	77;10	21;40

[361] It is wrongly included in Andalus; it should be placed in the next region of Sudan.

[362] Qulzūm (modern Suez) should be placed in Egypt above.

	Place Name	L	φ
24	Tā’if	77;30	21;20
Baḥrayn (Bahrain)			
25	ᶜAyāma[363]	82;30	23;0
26	Hajar Baḥrayn	83;0	25;35
27	Ḥasā Baḥrayn	83;30	24;0
28	Qaṭīfa ᶜArīn	74;0	25;0
Iqlīmhā Shām (the region of Syria)			
29	Bayt al-Maqdis az Filistīn	66;30	31;50
30	Asqalān az Filistīn	66;30	32;25
31	Ramla az Filistīn	66;50	32;10
32	Qaysāriyya	66;30	32;30
33	Tibariyya	68;0	32;0
34	Ṣawar	68;30	32;40
35	Ṣaydā	68;35	32;40
36	Ṭarābulus	69;40	34;0
37	Dimashq	70;0	33;15
38	Baᶜalbak	70;15	33;15
39	Ḥalab	72;10	35;50
40	Ṭarṭūs	68;40	36;42
Thughūr Rūm (the border lands of the Byzantines)			
41	Rūmiya Kabrī	85;27	41;50
42	ᶜAmmūriyya	64;0	43;45

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[363] This place belongs to Hejaz above.

	Place Name	L	φ
43	Arz al-Rūm	72;0	39;40
44	Arzinkān	76;0	38;0
45	Sīwās	71;40	39;0
46	Sumaysāṭ	72;35	40;0
47	Qālīqalā	73;25	39;0
	Second Circle		
Jazīra (the region of ancient Mesopotamia)			
48	Raqqa	73;15	36;0
49	Rās al-ᶜAyn	74;0	36;50
50	Mārdīn	74;0	37;15
51	ᶜĀna	76;30	34;0
52	Mawṣil	77;0	34;30
Armīn (Armenia)			
53	Arbīl[364]	72;20	35;0
54	Takrīt	78;20	34;30
55	Amid	73;40	38;0
Adarabyjān (Azerbaijan)			
56	Marāgha	82;0	37;20
57	Tabrīz	82;0	38;0
58	Ardabīl	82;30	38;0
Irān (Iran)			
59	Mūqān	83;0	38;0

[364] It should be included in the group above.

	Place Name	L	φ
60	Bardaᶜa	83;0	38;0
Kharkh (western shore of the Tigris river?)[365]			
61	Shamākhī Qaṣba Shirwān	84;30	40;50
62	Bāb al-Abwāb	85;0	43;0
Alān			
63	Alān	83;0	44;0
Rūs			
64	Kūsāna Madīnat Rūs	87;0	43;0
65	Sāmarra’	79;0	34;0
Bulghār			
66	Bulghār	90;0	49;30
67	Saqsīn	86;30	43;0
ᶜArāqayn (the two Iraqs)[366]			
68	Kūfa	79;30	31;30
69	Madā’in	72;0	33;10
70	Baghdād	80;0	33;25
71	Wāsiṭ	81;30	32;20
72	Baṣra	84;0	30;0
Khūzistān (a region in Iran)			
73	Arjān	86;30	29;32

365 Ulugh Beg has the heading Armenia once more here, in which are included Balkūya, Shamākhī and Bāb al-Abwāb.

366 Ulugh Beg has just ᶜIrāq here.

	Place Name	L	φ
74	Shābūr	86;15	30;10,0 !
Fārs (a province of Iran)			
75	Kāzirūn	87;0	29;15
76	Fīrūzābād	87;15	28;10
77	Shīrāz	88;30	29;36
ᶜIrāq			
78	Yazd	89;0	32;0
79	Shahrazūr	82;4	32;30
80	Qirmāsīn	43;0	34;30
81	Nahāwand	83;15	34;20
82	Hamadān	83;0	35;10
	Third Circle		
Iqlīmhā tatimma ᶜIrāq (continuation of the regions of Iraq)			
83	Karkh	84;45	34;0
84	Sāwa	85;0	35;0
85	Qazwīn	85;0	36;0
86	Iṣfahān	86;40	32;25
87	Kāshān	86;0	34;0
Dīlmān			
88	Qumm	85;40	34;45
89	Rayy	86;20	35;0
Kīlān (Gilan, a province of Iran)			
90	Ṭāliqān	85;45	36;10
91	Husūm az Jīlān	85;10	37;0

	Place Name	L	φ
Ṭabaristān (or Tapuria, southern coastal region of the Caspian Sea)			
92	Amul Qaṣba Ṭabaristān	88;20	36;15
93	Astarābād	89;35	36;50
Qūmish (a region in Iran)			
94	Dāmghān	88;55	36;20
95	Bisṭām	89;30	36;10
Khurāsān (Khorasan, a region in Iran)			
96	Sabzawār	91;30	36;0
97	Nīshābūr	92;30	36;21
98	Ṭūs	92;30	32;0
99	Ṭabas Kīlakī	92;0	33;0
100	Tūn	92;30	34;30
101	Harāt	94;20	34;32
102	Sarakhs	94;30	37;0
103	Marw al-Rūd	97;0	36;30
104	Fāriyāb	99;0	36;45
105	Balkh	101;0	36;41
	Fourth Circle		
Iqlīmhā Māwrā al-Nahr (the region of Transoxonia)			
106	Bukhārā	90;30	39;50
107	Samarqand	99;16	39;32
108	Khujand	100;35	41;55
109	Kāshghar	106;30	44;0
Kirmān (a province of Iran)			

	Place Name	L	φ
110	Hurmūz	92;0	25;0
111	Narmāshīr	94;20	29;0
Zābalistān (a region in Afghanistan)			
112	Ghazna Qaṣba Zābalistān	104;20	33;35
113	Banjāhīr Kābulistān	104;40	35;0
Makrān			
114	Kīj az Makrān	99;0	28;0
115	Jalq az Makrān	99;0	30;0
Sind			
116	Mansūra Qaṣba Sind	105;0	overwritten illegible
117	Qandahār	107;40	33;0
118	Lahāwar	109;20	31;50
Hind			
119	Akra	114;0	27;0
120	Dihlī	113;35	28;39

BACK

The rim of the two upper quadrants carries altitude scales which are divided in 1° and 5° and labelled as 5—90; 90—5.

In the upper left is a sexagesimal trigonometric quadrant, with 60 horizontal parallels with every fifth highlighted with dots. These are numbered in 5s along the vertical radius.

In the upper right is a solar quadrant with 30 declination arcs, one for each 10° of solar longitude. The names of the corresponding zodiac signs and the numerical values of their subdivisions are inscribed along the two radii. Upon these arcs are plotted two

graphs displaying the meridian altitude of the sun throughout the year at the latitudes 27° and 32°, with the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ 32* respectively.

In the lower half, just below the horizontal diameter are drawn two shadow squares, on the left for a base of 12 and on the right for a base of 7. The vertical and horizontal scales are divided and numbered accordingly and are endowed with the following scales; vertical scale on the left: *ẓill sullam aṣābiᶜ maᶜkūs* (scale of the reverse shadows in digits); horizontal scale on the left: *ẓill sullam aṣābiᶜ mustawī* (scale of the direct shadows in digits); horizontal scale on the right: *ẓill sullam aqdām mustawī* (scale of the direct shadows in feet); and vertical scale on the right: *ẓill sullam aqdam maᶜkūs* (scale of the reverse shadows in feet).

Figure A062.6 – Back of the Astrolabe (photo by S. R. Sarma)

Inside the shadow squares, there are two rectangular tables. The table on the left carries the heading *jadwal faḍl al-dawr* (table of excess revolution). This is the time measured in degrees of daily rotation (360° = 24h) by which the solar year exceeds 365 days. The table shows the multiples of the excess in minutes and seconds. The serial numbers in the first and the third columns are represented by the standard Arabic /

Persian numerals, while the differences in the second and third columns are expressed in the *abjad* notation.

Table A062-3 Excess of Revolution

1	87 33	10	155 31
2	175 6	20	61 2
3	262 39	30	106 33
4	350 12	40	262 10
5	77 45	50	57 35
6	164 19	60	213 6
7	252 52	70	08 37
8	340 25	80	164 8
9	67 58	90	319 39

The table on the right has the title *jadwal arbāb muthallathāt laylī wa nahārī* (table of the regents of the triplicities, nocturnal and diurnal). There are four sub-tables arranged according to the four elements fire, earth, air and water.

Here the regents of the day and the regents of the night are in the same column; the first two rows show the sign and the day regent, while the next two rows mention the sign and the night regent. Thus Aries has the sun as the regent in the daytime and Jupiter as the regent at night.

Table A062-4 Triplicities and Regents

nārī (fiery)				*tarabī* (earthy)		
Aries	Taurus	Gemini		Cancer	Leo	Virgo
Sun	Jupiter	Saturn		Venus	Moon	Mars
Aries	Leo	Sagittarius		Taurus	Virgo	Capricorn
Jupiter	Sun	Saturn		Moon	Venus	Mars
hawā’ī (airy)				*māhī* (watery)		
Libra	Scorpio	Sagittarius		Capricorn	Aquarius	Pisces
Saturn	Mercury	Jupiter		Venus	Mercury	Moon

Gemini	Libra	Aquarius		Cancer	Scorpio	Pisces
Mercury	Saturn	Jupiter		Mars	Venus	Moon

The shadow squares are enclosed in a series of 8 concentric semi-circular scales. The two outermost scales on the rim are the cotangent scales and their subdivisions. The scale on the left is in digits; the unequal divisions here are numbered clockwise from the vertical diameter as 1, 2, 3, …18, 24, 30, … 60, followed by the label *ẓill aṣābi*^{c} *mabsūṭ*. The scale on the right is in feet; the unequal divisions here are numbered anti-clockwise from the vertical diameter as 1, 2, 3, … 12, 18, 24, …60, followed by the label *ẓill aqdām mabsūṭ*.

The two semi-circular rows which follow contain the names of the 12 zodiac signs and the names of the 28 lunar mansions, showing their interrelationship.

The next two rows display the limits of the signs (*ḥudūd*) while the last two rows exhibit the decans (*wujūh*) and their regents.

ALIDADE

The alidade has ornate ends and an ornate centre-piece. The upper register on the right hand side carries a scale numbered in 6s from the centre to the tip as 6, 12, 18 … 60. This scale matches with the divisions of the vertical radius of the upper left quadrant, but unusually, the alidade is not graduated in single units.

The lower register on the right has unequal divisions numbered from 1 to 6 from the sighting plate onwards and again numbered from 7 to 12 in the reverse direction. When the alidade is used as a sundial with the sighting plate on the right as the gnomon, the shadow thrown by the sighting plate across the length of the alidade is measured on this scale in seasonal hours.

The right arm of the alidade is engraved with declination arcs together with the names of the six pairs of signs as in the upper right quadrant.

The sighting plates are equipped with two holes each. A sighting tube passes through the larger holes. It is difficult to say whether the tube was original or added later. At present the tube is slightly bent. [367]

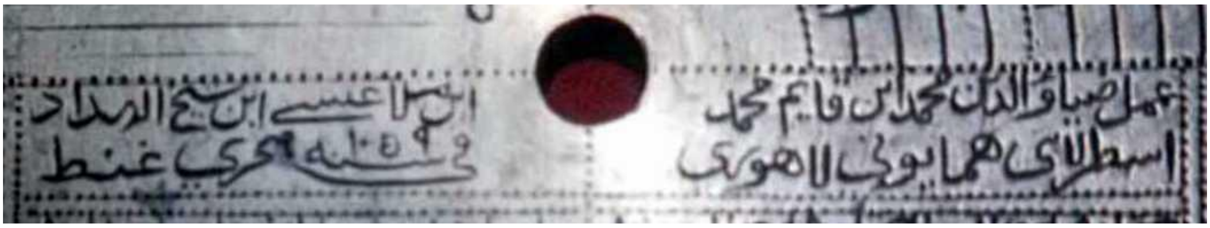

Figure A062.7 – Astrolabe maker’s signature and date (detail of Figure A048.4)

INSCRIPTION

Immediately below the horizontal diameter is the astrolabe maker’s signature, where the year of manufacture is given in common Arabic/Persian numerals as well as in the *abjad* notation:

> *ᶜamal ḍiyā’ al-dīn muḥammad ibn qā’im muḥammad*
> *ibn mullā ᶜīsā ibn shaykh allāhdād*
> *asṭurlābī humāyūnī lāhūrī*
> *fī sanah 1059 hijrī gh-n-ṭ*
>
> ‘The work of Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1059 Hijrī, [in *abjad* 1000+50+9] 1059.’

BIBLIOGRAPHY

Nadvi 1935.

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[367] There are some of astrolabes by Ḍiyā’ al-Dīn where it is difficult to decide whether the sighting tube is original. However, the sighting tube is original in Ḍiyā al-Dīn’s east-west astrolabe (A090).

A063 ASTROLABE BY ḌIYĀ AL-DĪN MUḤAMMAD, 1059 AH (AD 1649-50)

Diameter 190 mm

PLU: ex-London, Sotheby's (Catalogue 14 April 2010, lot 119)

Figure A063.1 – Front of the astrolabe (© Sotheby's)

This highly ornate astrolabe by Ḍiyā’ al-Dīn was not noticed previously until it came up for auction at Sotheby’s of London in 2010.

COMPONENTS

Body with *kursī* (d. 190, h. 285), shackle and ring, rete, 5 plates, alidade, pin and horse.

FRONT

The trifoliate shackle has bases shaped like tear drops. The *kursī* is very elaborately reticulated and engraved. The profiles consist of an ogee rising from the limb, followed by a lobe and another ogee, topped by trifoliate finial. The horizontal petals of the trefoil stretch out and curve into sharp points. The same motif is repeated below in the middle of the *kursī* and also in the rete at its north point. The surface on both sides of the *kursī* is filled with very ornate engravings.

The limb is divided in 1° and 5° and labelled from 5 to 360.

RETE

The two rings of the Tropic of Capricorn and ecliptic are held together by the equinoctial bar which has counter changes at its intersection with the ecliptic. The spaces between the two rings are filled with an intricate and symmetrical floral design of tulips with flared petals on long curved stems. A part of the tracery below the ecliptic ring is broken off and the Capricorn ring is slightly distorted on the lower left. The star names are inscribed in very small letters and cannot be deciphered.

PLATES

There are five plates to serve latitudes 22° and 25°; 27° and 28°; 32° and 36°; 0° + 90° and ?; tablet of ecliptic coordinates and tablet of horizons. On the first three plates, altitude circles are drawn for each 2° and azimuth circles for each 6°.

GEOGRAPHICAL GAZETTEER

The gazetteer carries the names, longitudes and latitudes of 108 localities in Greater Iran and India.

Figure A063.2 – Back of the astrolabe (© Sotheby’s)

BACK

The rim of the two upper quadrants bears altitude scales which are divided in 1° and 5° and labelled as 5—90; 90—5. The rim on the lower half carries cotangent scales.

In the upper left is a sexagesimal trigonometric quadrant with 60 horizontal and 60 vertical parallels, with each fifth highlighted with dots. The horizontal lines are numbered in 5s along the vertical radius. In the upper right is a solar quadrant with 30

declination arcs, one for each 6° solar longitude. The names of the corresponding zodiac signs are inscribed along the two radii, together with their subdivisions. Upon these are superimposed two sigmoid curves displaying the meridian altitude of the sun throughout the year at the latitudes of 27° (Agra) and 32° (Lahore). These carry the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27* (line of midday at latitude 27°) and *khaṭṭ niṣf al-nahār bi-ᶜarḍ 32* (line of midday at latitude 32°) respectively.

In the lower half, just below the horizontal diameter are drawn two shadow squares, on the left for a base of 7 and on the right for a base of 12. The vertical and horizontal scales are divided and numbered accordingly, and accompanied by the following labels: vertical scale on the left: *ẓill sullam aqdām mᶜakūs* (the scale of reverse shadows in feet); horizontal scale on the left: *ẓill sullam aqdām mustawī* (the scale of direct shadows in feet); *ẓill sullam aṣābiᶜ mustawī* (the scale of direct shadows in digits); and *ẓill sullam aṣābiᶜ mᶜakūs* (the scale of reverse shadows in digits).

Inside the shadow squares, there are two rectangular tables. On the left a table with the heading *jadwal faḍl al-dawr* (table of excess of revolution) showing the multiples of the difference (in minutes and seconds) between the approximately correct length of the tropical year and 365 days. On the right is a table displaying the triplicities and their diurnal and nocturnal regents, in four sub-tables, each devoted to an element: *nārī* (fiery), *tarābī* (earthy), *hawā'ī* (airy) and *māhī* (watery). Probably there is a heading *jadwal arbāb muthallathāt laylī wa nahārī* (table of the nocturnal and diurnal regents of the triplicities), but it is obscured by the alidade in the available photo.[368]

The shadow squares are enclosed in a series of 8 concentric semi-circular scales; counting from the outside, these represent the following:

1-2: cotangent scales and their subdivisions

3-4: zodiac signs and lunar mansions, showing their interrelationship

5-6: table of the limits (*ḥudūd*) of the signs

7-8: table of the decans (*wujūh*) and their regents.

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[368] The catalogue mentions only the table on the left and not the one on the right.

ALIDADE

The alidade has ornate ends and an ornate centre-piece. The right hand side carries a sexagesimal scale, numbered in 5s from 5 to 60 from the centre to the end to match the divisions on the upper left quadrant. The left hand side bears a zodiac scale with the names of pairs of signs in each division to match the solar quadrant in the upper right.

INSCRIPTION

Below the shadow squares is the maker’s inscription with the following purport:

> ‘Made by Ḍiyā’ al-Dīn, son of Qā’im Muḥammad, son of Mullā ʿĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1059 Hijrī.’

The year translates to AD 1649-50.

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Sotheby’s, London, auction catalogue, 14 April 2010, lot 119, pp. 82-83.

A064 ASTROLABE BY ḌIYĀ AL-DĪN MUḤAMMAD, 1060 AH (AD 1650-51)[369]

Diameter 314 mm

PLU; ex-New York, The Brooklyn Museum (# X638.2)

CCA 3555; Répertoire 8

Figure A064.1 – Front of the astrolabe (Image courtesy of the Brooklyn Museum; object reported as stolen to The Art Loss Register, Inc. 1999, former collection of the Brooklyn Museum x638.2.)

369 Entry based on Savage-Smith 1992a.

This astrolabe was published for the first time by Emilie Savage-Smith in her comprehensive study of the ‘Celestial Mapping’ with a detailed listing of the stars on the rete, a valuable diagram of the rete and photos of the rete, gazetteer, back and the plate for latitude 29. Upon my request, the Brooklyn Museum kindly sent me a clear photo of the front and photocopies of the plates for latitudes 22°, 25°, 27° and 31;50°, but expressed their inability to provide photos of the gazetteer and the back. In the absence of good photos of these, the gazetteer and especially the back cannot be described completely. Now the Museum informs me that the astrolabe was stolen in 1999.

COMPONENTS

Body with *kursī* (d. 314), shackle and ring, rete for 53 stars, 4 plates. Alidade, pin and horse are missing.

FRONT

Plain ring, shackle of trifoliate shape but with plain circular bases; very finely pierced *kursī* with profiles made up of ogees and lobes and a trifoliate finial. The limb is divided in 1° and 5° and labelled from 5 to 360.

RETE

The two circles of Capricorn and ecliptic are held together by the equinoctial bar with counter changes at its two intersections with the ecliptic. The space inside these two circles is filled with an elaborate floral tracery connecting the 53 star pointers. The ecliptic circle is divided into the 12 signs of the zodiac and labelled with their names; each sign is divided into groups of 5° and labelled as 5, 10, 15, 20, 25, 30; this is quite unusual, the general practice being to divide the signs into groups of 6°. The sloped edge is divided into 1°. The names of the 53 stars engraved on the star pointers were deciphered and identified by Emilie Savage-Smith. These are reproduced here with slight modifications.

Table A064-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus al-Janūbī*	β Ceti
2	*Baṭn al-Ḥūt*	β Andromedae
3	*Fam al-Qayṭus*	γ Ceti
4	*Ṣadr al-Qayṭus*	π Ceti
5	*Rās al-Ghūl*	β Persei
6	*Mirfāq al-Thurayyā*	α Persei
7	*Masāfat al-Nahr*	γ Eridani
8	*ᶜAyn al-Thawr*	α Tauri
9	*ᶜAyyūq*	α Aurigae
10	*Rijl al-Jawzā' al-Yusrā*	β Orionis
11	*Yad al-Jawzā' al-Yusrā*	γ Orionis
12	*Yad al-Jawzā' al-Yumnā*	α Orionis
13	*Rijl al-Jawzā' al-Yumnā*	κ Orionis
14	*Shiᶜrā Yamānī*	α Canis Majoris
15	*Rās al-Taw'am al-Muqaddam*	α Geminorum
16	*Shiᶜrā Shāmī*	α Canis Minoris
17	*Ṭarfat al-Safīna*	ρ Puppis
18	*Maᶜlaf*	M44 Cancri
19	*Fard al-Shujāᶜ*	α Hydrae
20	*Qalb al-Asad*	α Leonis
21	*Ẓahr al-Dubb al-Akbar*	α Ursae Majoris
22	*Qā'idat al-Bāṭiya*	α Crateris

	Star Name	Identification
23	*Ẓahr al-Asad*	δ Leonis
24	*Ṣarfa*	β Leonis
25	*Anwār al-Farqadayn*	β Ursae Majoris
26	*ᶜAnāq*	ζ Ursae Majoris
27	*Janāḥ al-Ghurāb*	γ Corvi
28	*Simāk Aᶜzal*	α Virginis
29	*Simāk al-Rāmiḥ*	α Bootis
30	*Kiffa Janūbī*	$\alpha^{1,2}$ Librae
31	*Kiffa Shamālī*	β Librae
32	*Nayyir al-Fakka*	α Coronae Borealis
33	*ᶜUnuq al-Ḥayya*	α Serpentis
34	*Qalb al-ᶜAqrab*	α Scorpii
35	*Rijl al-Ḥawwā’ al-Yamīnī al-Muqaddam*	ρ Ophiuchi
36	*Rās al-Jāthī*	α Herculis
37	*Rās al-Ḥawwā’*	α Ophiuchi
38	*ᶜAyn al-Tinnīn*	γ Draconis
39	*Yad al-Ḥawwā’ al-Yumnā al-Muqaddam*	δ Ophiuchi
40	*Nasr Wāqiᶜ*	α Lyrae
41	*ᶜIsābat al-Rāmī*	ρ Sagittarii
42	*Minqār al-Dajāja*	β Cygni
43	*Nasr al-Ṭā’ir*	α Aquilae
44	*Qarn al-Jadī al-Thānī*	α Capricorni
45	*Dhanab al-Dulfīn*	ε Delphini

	Star Name	Identification
46	*Dhanab al-Dajāja*	α Cygni
47	*Fam al-Faras*	ε Pegasi
48	*Dhanab al-Jadī*	δ Capricorni
49	*Mankib Sākib al-Mā'*	α Aquarii
50	*Sāq Sākib al-Mā' Janūbī*	δ Aquarii
51	*Dhanab al-Qayṭus Shamālī*	ι Ceti
52	*Mankib al-Faras*	β Pegasi
53	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are four plates. The Brooklyn Museum kindly sent me photocopies of the four plate faces; Savage-Smith published a fifth plate face. The tablet of horizons with the label *ṣafīḥa āfāqī* can be seen below the rete in the photo of the front sent by the Brooklyn Museum. No information is available about the remaining two plate faces; one of these could be the tablet of ecliptic coordinates. It is also not known how these six plates are interrelated.

Table A064-2 Plates

	φ	**Longest Day hours**	***ghaṭīs***	**correct value in *ghaṭīs***
1	22°	13;21 hours	33 *karhā*	33;17,30
2	25°	13;35 hours	33 (!) *karīha*	33;56,15
3	27°	13;43 hours	---	
4	31;50°	14;7 hours	---	
5	29	13;52 hours	34 *karhā*	34;40
6	Tablet of horizons			

	φ	Longest Day hours	*ghaṭīs*	correct value in *ghaṭīs*
7	?			
8	?			

On the plates calibrated for a particular latitude, altitude circles are drawn for every 1°, with each fifth dotted. Azimuth arcs are drawn for every 6°, above and below the horizon on the plates for 22° and 29°, and only below the horizon on the remaining plates. Each fifth azimuth arc is dotted.

Plain lines for seasonal hours are drawn. On the plates for 27° and 31;50°, lines for equal hours are drawn from the western and eastern horizons. On the plates for 22° and 25°, plain lines for equal hours as counted from the western horizon are drawn; in addition, dotted lines for *ghaṭīs* as counted from the western horizon are drawn. On these three plates, the duration of the longest day is also given in complete *ghaṭīs* (*karhā* or more correctly *karīhā*), ignoring the fractions.

GEOGRAPHICAL GAZETTEER

The gazetteer is engraved in four circles providing, besides the usual place name, longitude and latitude, also the duration of the longest day (*al-sāᶜāt*), for 260 localities. However, the duration ignores minutes and gives only the hours. The gazetteer does not commence exactly at the top, below the zero of the degree scale, but strangely 7° to the left, below 353°. The style of presentation and of calligraphy is totally different from the other astrolabes by Ḍiyā’ al-Dīn.

BACK

The rim of the upper half contains altitude scales which are divided in 1° and 5° and labelled 5—90; 90—5.

In the upper left is a trigonometric quadrant with 60 horizontal parallels, with every fifth dotted; these are numbered in 5s along the vertical radius. In the upper right is a solar quadrant with 60 equally spaced concentric declination arcs, with every fifth dotted; the names of the corresponding zodiac signs are written along the two radii.

Moreover, radial lines are also drawn for every 5°. Upon this grid are plotted three graphs of solar meridian altitude for the latitudes 27°, 29° and 32° with the usual labels.

In the lower half are the shadow squares, on the left for a base of 7 feet and on the right for a base of 12. These enclose a large rectangular table of multiples of excess revolution with the heading *jadwal faḍl al-dawr*. Below this is a smaller table which cannot be identified.

The shadow squares are encircled by 10 semi-circular rows. The first 8 rows contain, as in other large astrolabes by Ḍiyā' al-Dīn, the cotangent scales, the names of the 28 lunar mansions and the names of the corresponding 12 zodiac signs, the limits of signs, the decans and their regents.

These are followed by two more semi-circular rows which cannot be deciphered in the faint reproduction which is available. There seem to be two separate tables on the left and right. In the table on the left, one row carries the names of the signs from Libra to Pisces.

Inscription (according to the Répertoire)

Directly below the horizontal diameter is the astrolabe maker's signature:

> *ᶜamal [aqall] al-ᶜibād mullā ḍiyā' al-dīn muḥammad ibn mullā qā'im muḥammad ibn ḥāfiẓ ᶜīsā ibn shaykh allāhdād asṭurlābī humāyūnī sanah 1060.*
>
> 'The work of [the weakest of] the servants [of God], Mullā Ḍiyā' al-Dīn, son of Mullā Qā'im Muḥammad, son of Ḥāfiẓ ᶜĪsā, son of Shaykh Allāhdād, the astrolabe maker to [the Emperor] Humāyūn in the year 1060 [Hijrī].'

The inscription strangely omits *aqall* in the standard phrase of humility *aqall al-ᶜibād.* Ḍiyā' al-Dīn adds the attribute *mullā* to his name and as well as to his father's, while the grandfather is styled *ḥāfiẓ* and the great-grandfather *shaykh.* The Hijrī year translates to AD 1650-51.

Provenance

The museum informs me, through their mail of 21 March 2016, that the astrolabe was stolen in 1999.

Bibliography

Savage-Smith 1992a.

A065 ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1061 AH (AD 1650-51)

Diameter 210 mm

PLU, ex-London, Christie’s (catalogue 24 September 1992, lot 113)

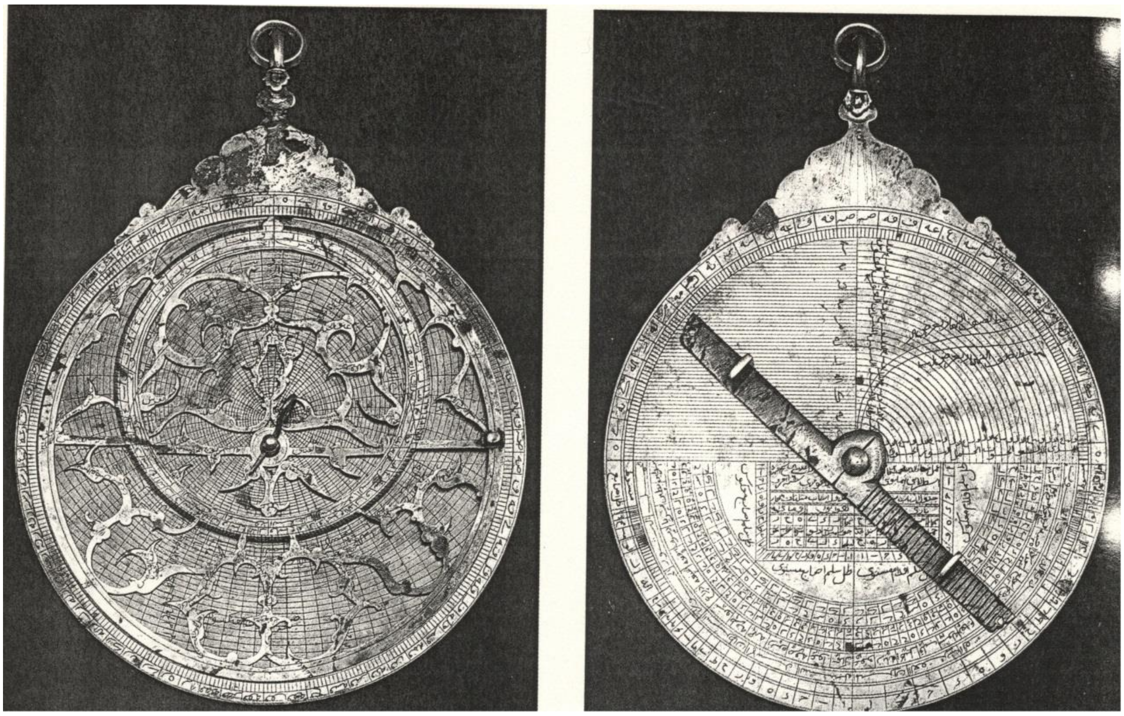

Figure A065.1 – Front and back of the astrolabe (© Christie’s, London)

COMPONENTS

Body (d. 210) with *kursī,* ring and shackle, rete, 5 plates, alidade and pin. The alidade is a replacement; the wedge is missing.

FRONT

Plain ring, shackle with trifoliate form and trifoliate bases; the *kursī* is solid, with profiles made up of two ogees with a lobe in between, finial trifoliate. The catalogue says that there is a faint engraving on the surface of the *kursī* and also on the edge of the body. The limb is divided in 1° and 5° and labelled from 5 to 360. Inside the limb, there is a plug at the south point, which is rather unusual.

RETE

The Capricorn ring and the ecliptic ring are held together by the equinoctial bar which has counter changes at its two intersections with the ecliptic ring. The ecliptic ring is divided into the 12 zodiac signs and labelled with their names, each sign is subdivided into units of 6° each which are numbered separately in each sign from 6 to

30. The edge of the ecliptic ring appears to be calibrated for 1°. There are about 40 named star pointers.

PLATES

The catalogue says: ‘two original **plates,** two later replacements’. But the illustration on the facing page shows 5 plates, with the following particulars.

1. Tablet of horizons with four notches at the four cardinal points; four sets of half-horizons, but not declination scales, nor a label mentioning the name of the plate.

2. Tablet of ecliptic coordinates with latitude circles for every 2° and longitude circles for each 6°. Above the north point, there is the label *ṣafīḥat mīzān al-ᶜankabūt.*

3. Plate for latitude 32°. Altitude circles for every 2°, azimuth arcs below the horizon for every 6°, lines for seasonal hours and for equal hours from the western horizon. In the middle of the plate is engraved *al-ᶜarḍ 32* and *sāᶜāt 14;8.*

4. Plate for latitude 23°. Altitude circles for every 3°, azimuth arcs above the horizon for each 9°, lines for seasonal hours and lines for equal hours drawn from the western horizon. In the middle of the plate is engraved, in much larger letters than in in the previous plate, *ᶜarḍ 23.* The maximum duration of daylight cannot be read.

5. Plate probably for latitude 36°; the circles as above. The latitude and the daylight hours are engraved, but cannot be read.

Possibly the nos. 4 and 5 are replacements. Plates 2-5 have notches at the south point to fit into the plug placed at the south point in the limb. It is unusual that the tablet of horizons and the tablet of ecliptic coordinates are engraved on two separate plates.

GEOGRAPHICAL GAZETTEER

The catalogue says ‘inner face with qibla directions and localities,’ but the photo of the gazetteer on p. 39, shows clearly the argument as *asmā al-buldān* (place names), *al-ṭūl* (longitude) and *al-ᶜarḍ* (latitude) for 108 localities. There are no *qibla* directions.

BACK

The rim of the two upper quadrants carries altitude scales divided in 1° and 5° and labelled as 5—90; 90—5. In the upper left quadrant are 60 horizontal parallels, which are numbered in 5° along the vertical radius from 5 to 60. In the upper right quadrant are drawn 30 quarter circles, one for each 6° of solar longitude. The names of the corresponding zodiac signs are inscribed along the two radii, together with the

subdivisions of the signs. Two sigmoid graphs of the midday altitude of the sun throughout the year at latitudes 27° and 32° are drawn along with the usual labels.[370]

In the lower half are drawn shadow squares, on the left for a base of 12 and on the right for a base of 7. The scales are accompanied by the usual labels.

Within the shadow squares there are two rectangular tables. The table on the left displays the triplicities and their diurnal regents while that on the right shows the triplicities and their nocturnal regents.

The rim of the lower half carries the cotangent scales, on the left in digits and on the right in feet. These are followed by six semi-circular rows containing the names of the 12 signs, the names of the 28 lunar mansions, the limits of the signs, the decans and their regents.

INSCRIPTION

Immediately below the horizontal diameter is inscribed the astrolabe maker’s signature together with the year of manufacture 1061 Hijrī (= AD 1650-51).

BIBLIOGRAPHY

Christie’s, London, auction catalogue, 24 September 1992, lot 113, pp. 38-39.

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370 The catalogue describes the quadrant erroneously: ‘the upper right quadrant with scale for unequal hours’.

A066⊙ ASTROLABE BY ḌIYĀ AL-DĪN MUḤAMMAD, 1062 AH (AD 1651-52)

Diameter 149 mm

Cardiff, Welsh National Museum (# 39.573/2)

CCA 1107; Répertoire 10

Figure A066.1 – Front of the astrolabe (photo by S. R. Sarma)

COMPONENTS

Body with *kursī* (d. 149, h. 197, t. 7), shackle and ring, rete (d. 135) for about 37 stars, 4 plates and alidade. The original pin and horse are lost. The components are held together by a modern bolt and nut.

FRONT

The ring is plain and the shackle trifoliate. The *kursī* is elegant with fretwork and ornate patterns engraved on the surface. The profiles are made up of a lobe between two ogees and topped by trefoil. The limb is divided in 1° and 5° and labelled from 5 to 360.

Figure A066.2 – Rete of the astrolabe (photo by S. R. Sarma)

RETE

The Capricorn and ecliptic ring are held together by an equinoctial bar which has counter changes at the centre, at vernal equinox, and, most unually, in the eastern

segment as well. The solstitial bar is shown completely, not as a continuous strip, but with a series of oval frames.

The ecliptic circle is divided into the 12 signs and labelled with their names; each sign is divided into 5 parts and the parts numbered as 6, 12, 18, 24, 30.

There are about 37 named star pointers which are joined by frames of diverse shapes. The star pointer Vega is shown as a bird inside a cage-like oval frame.

Plates

Four plates nest inside the mater; there is still space for more plates; perhaps one or two plates are missing, in particular a fifth plate with ecliptic coordinates and multiple horizons.

Table A066-1 Plates

	φ	Longest day
1a	22°	13;22 hours
1b	25°	13;35 hours
2a	18°	13;12 hours
2b	29°	13;55 hours
3a	27°	13;43 hours
3b	36°	14;32 hours
4a	24°	13;25 hours
4b	32°	14;8 hours

Geographical Gazetteer

On the inner surface of the mater is engraved a geographical gazetteer in three circles with the names, longitudes and latitudes of 69 localities.

Back

The rim of the two upper quadrants bears altitude scales which are divided in 1° and 5° and labelled as 5—90; 90—5.

In the upper left are drawn 60 horizontal parallels with every fifth highlighted with dots. These are numbered along the vertical radius from 5 to 60.

Figure A066.3 – Back of the astrolabe (photo by S. R. Sarma)

Eighteen equally spaced declination arcs are drawn in the upper right quadrant, so that the spaces between the arcs represent 10° of solar longitude. Along the two radii

are inscribed the names of the corresponding zodiac signs and the degrees of the three decans. Upon this grid are drawn two graphs of solar meridian altitude for the latitudes 27° and 32° with the usual labels.

In the lower half are shadow squares, on the left for a base of 7 feet and on the right for a base of 12 digits. On the left the vertical and horizontal scales are divided into 7 parts each and the parts are numbered from 1 to 7. On the right the scales are divided into 6 parts each and parts are numbered 2, 4, … 12. In adjoining scales, these parts are halved to produce 12 parts in all. The scales are accompanied by the usual labels.

The shadow squares are enclosed in 8 concentric semi-circular rows. The outermost row carries the cotangent scales, on the left for feet and on the right for the digits. The scale on the left bears the numbers 1, 2, 3, … 12, 18, 24, 30, 36, 42, 48, 60, followed by the label *ẓill aqdām mabsūṭ*. The right half also bears the same numbers, but followed by the phrase *ẓill aṣābi*ᶜ *mabsūṭ*. The next semi-circular row carries the subdivisions (of 1 unit) of the cotangent scale.

The next two rows are engraved respectively with the names of the signs of the zodiac and the names of the lunar mansion and thus show the correlation between these two sets of units. Thereafter, two rows display the limits of the signs and the last two rows the decans and their regents.

Within the shadow squares is a table showing the multiples of the difference between the approximately correct length of the tropical year and 365 days, but its name *faḍl al-dawr* is not engraved.

ALIDADE

The alidade has ornate ends and an ornate centre-piece. Unusually, it is graduated only on the right hand side with a sexagesimal scale, numbered in 5s from 5 to 60. The left hand side is completely blank. The sighting plate on the left is missing.

INSCRIPTION

Just below the horizontal diameter is engraved the astrolabe maker's name and his genealogy. The year of manufacture is added below the shadow squares.

*ṣan*ᶜ*at ḍiyā' al-dīn muḥammad*

ibn qā'im muḥammad ibn mullā ᶜ*īsā*

ibn shaykh allāhdād asṭurlābī
humāyūnī lāhūrī
fī sanah 1062 hijrī
‘The work of Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1062 Hijrī.’ The year corresponds to AD 1651-52.

A067⊙ ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1062 AH (AD 1651-52)[371]

Diameter 266 mm

Hyderabad, Salar Jung Museum (#112/2/xxxv)

Figure A067.1 – Front of the astrolabe (photo by S. R. Sarma)

371 I had the privilege of accompanying Professor David King when he examined this astrolabe in 1991. This description is partly based on his notes. I copied the gazetteer on a subsequent visit.

It is one of Ḍiyā’ al-Dīn’s large astrolabes with a finely crafted *kursī*, a gazetteer of 156 places, and as many as eight solar meridian altitude curves.

COMPONENTS

Body with *kursī* (d. 266, h. 306, t. 13), shackle and ring, rete for 52 stars, 6 plates. The original alidade, pin and horse are missing. These are replaced by a crude alidade with a sighting tube, a modern threaded bolt and a winged nut. Moreover, a semi-circular loop is attached to the ring at a later point. On the back, two long strips were hammered onto the profile of the *kursī* on the left and over the altitude scale on the right (see Figure A067.3). In the latter place the divisions of the scale are carefully re-engraved on the strip. These appear to be repairs of later times.

FRONT

The shackle is trifoliate. The simple fretwork in the *kursī* is highly elegant, producing five tulip flowers, an upright one in the middle with an upside-down flower on either side. The flared petals of two larger tulips form the profiles with lobes and ogees; it is reminiscent of some of Muqīm’s astrolabes (A021; A049). The finial is trifoliate.

The limb is divided in 0;20°, 1°, 3° and numbered in 3s from 3° to 360°.

RETE

The equinoctial bar on the rete is complete and is counter-changed at the centre and at the two points of intersection with the ecliptic. The ecliptic is divided into signs, each sign is further divided in groups of 6° and then in single degrees. The rete displays a large number of star pointers, representing the positions of as many as 52 stars. These pointers are joined by a tracery of a highly accomplished and almost symmetrical floral pattern. There is a handle on the outer periphery of the rete at a place nearly midway between the north and west points.

The following are the star names engraved on the star pointers.

Figure A067.2 – Rete of the Astrolabe (photo by S. R. Sarma)

Table A067-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
2	*Baṭn al-Ḥūt*	β Andromedae
3	*Rijl al-Musalsala*	γ Andromedae
4	*Mu’akhkhar al-Sharṭayn*	γ Arietis
5	*Fam al-Qayṭus*	γ Ceti
6	*Ṣadr al-Qayṭus*	π Ceti

	Star Name	Identification
7	*Rās al-Ghūl*	β Persei
8	*Kaff al-Jadhmā’*	α Ceti
9	*Tālī Masāfat al-Nahr*	γ Eridani
10	*ᶜĀyn al-Thawr*	α Tauri
11	*ᶜAyyūq*	α Aurigae
12	*Rijl al-Jawzā’ al-Yusrā*	β Orionis
13	*Yad al-Jawzā’ al-Yusrā*	γ Orionis
14	*Rijl al-Jawzā’ al-Yumnā*	κ Orionis
15	*Yad al-Jawzā’ al-Yumnā*	α Orionis
16	*Shiᶜrā Yamānī*	α Canis Majoris
17	*Ṭarfat al-Safīna*	ρ Puppis
18	*Shiᶜrā Shāmī*	α Canis Minoris
19	*Miᶜlāf*	M44 Cancri
20	*Fard al-Shujāᶜ*	α Hydrae
21	*Rās al-Asad*	μ Leonis
22	*Ẓahr Dub al-Akbar*	α Ursae Majoris
23	*Qāᶜidat al-Bāṭiya*	α Crateris
24	*Ẓahr al-Asad*	δ Leonis
25	*Ṣarfa*	β Leonis
26	*Janāḥ al-Ghurāb*	γ Corvi
27	*Simāk Aᶜzal*	α Virginis
28	*ᶜAnāq*	ζ Ursae Majoris
29	*Simāk Rāmiḥ*	α Bootis
30	*Kaffa J[anūbī]*	α Librae

	Star Name	Identification
31	*Kaffa Sh[amālī]*	β Librae
32	*Nayyir Fakka*	α Coronae Borealis
33	*ᶜUnuq al-Ḥayya*	α Serpentis
34	*Rukbat ḥ-w-s-r-y* (?)	
35	*Rās al-Jāthī*	α Herculis
36	*ᶜĀyn al-Tinnīn*	γ Draconis
37	*Rās al-Ḥawwā’*	α Ophiuchi
38	*Yad al-Ḥawwā’ al-Yumnā al-Muqaddam*	δ Ophiuchi
39	*Nasr Wāqiᶜ*	α Lyrae
40	*Minqār al-Dajāja*	β Cygni
41	*Nasr al-Ṭā’ir*	α Aquilae
42	*Dhanab al-Dulfīn*	ε Delphini
43	*Dhanab al-Dajāja*	α Cygni
44	*Dhanab al-Jady*	δ Capricorni
45	*Fam al-Faras*	ε Pegasi
46	*Mankib Sākib al-Mā’*	α Aquarii
47	*Sāq Sākib al-Mā’*	δ Aquarii
48	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
49	*Mankib al-Faras*	β Pegasi
50	*Kaff al-Khaḍīb*	β Cassiopeiae
51	*Surrat al-Faras*	δ Pegasi
52	*Janāḥ al-Faras*	γ Pegasi

PLATES

There are six plates with the following specifications.

Table A067-2 Plates

	φ	Longest Day hours	*ghaṭīs*	correct *ghaṭīs*
1a	17°	13;07	32;37	32;47,30
1b	19°	13;15	32;55	33;7,30
2a	21°	13;16,56	33;12,20	correct
3a	27°	13;43	34;17	34;27,30
2b	29°	13;58,56	34;52,20	34;57,20
3b	32°	14;8	35;20	correct
5a	35°	14;22	35;55	correct
6a	40°	14;52		
4a	30°+44°			
5b	0°+90°			
4b	Tablet of ecliptic coordinates			
6b	Tablet of horizons			

On the plate faces serving a single terrestrial latitude, altitude circles are drawn for every 1° and each sixth line is dotted. Azimuth circles are plotted below the horizon for each 6°. Lines for seasonal hours are drawn. On some plates, there are also dotted lines for equal *ghaṭīs* drawn from the western horizon and numbered from there in *abjad* notation. On plate faces 3a, 3b, 5a the *ghaṭīs* are numbered in standard Arabic/Persian numerals. Because two and half *ghaṭīs* (of 24 minutes each) make one hour (60 minutes), certain *ghaṭīs* are divided into two parts to synchronize with the equal hours. Thus *ghaṭī* numbers 3, 8, 13, 18, 23, 28 are halved so that time can be measured in both the *ghaṭī* and equal hours from these lines.

On these plates, below the Tropic of Cancer, are engraved the value of the latitude and the maximum duration of the daylight at this latitude in hours, as is the usual

practice. In six cases, the duration of the longest day is also mentioned in *ghaṭīs* and *palas* (spelt *kahrī* and *pal* respectively). However, in four cases the values in *ghaṭīs* are not correct as shown in the table above.[372]

Plate 4a has a double projection to serve two latitudes 30° and 44°. Here altitude circles are drawn for every 2° and every fifth is highlighted with dots. There are lines for seasonal hours and dotted lines for equal hours drawn from the western horizon.

Three sets of circles are engraved on plate 5b. In the upper left are altitude circles for each 2° and azimuth arcs for each 6° for latitude 0°. In the upper right are altitude circles for each 2° above and below horizon for latitude 90°. In the lower half are drawn azimuth circle for each 2° and lines for seasonal hours at latitude 0°. Under the horizontal diameter in the east is engraved *lā ᶜarḍ lah* (there is no latitude) and *sāᶜāt 12* (maximum duration 12 hours) and in the west *ᶜarḍ tisᶜūn* (latitude 90).

Geographical Gazetteer

On the inner side of the mater, a geographical gazetteer of 156 localities is engraved with their longitudes and latitudes in four concentric circles.

Table A067-3 Geographical Gazetteer

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
	First Circle		
1	Sāwa	85;0	35;0
2	Qazwīn	85;0	36;0
3	Iṣfahān	86;40	32;25
4	Kāshān	86;0	34;0
5	Qum	85;40	34;45
6	Rayy	86;20	35;0
7	Tāliqān	85;45	36;10

[372] It is incomprehensible why errors occur in this simple conversion where 1 hour of 60 minutes = 2.5 *ghaṭīs* of 24 minutes. Such errors can be seen in other Indo-Persian as well as in Sanskrit astrolabes.

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
8	Astarābād	89;35	36;50
9	Jurjān	90;0	36;50
10	Sumnān	88;0	36;0
11	Dāmqān	88;55	36;20
12	Busṭām	89;30	36;10
13	Sarwār	91;30	36;5
14	Nīshābūr	92;30	36;21
15	Ṭūs	92;30	36;0
16	Turshīz	92;0	36;0
17	Tūn	92;30	35;0
18	Qā’in	93;20	33;40
19	Harāt	94;20	34;30
20	Sarakhs	94;30	37;0
21	Marw	97;0	37;40
22	Fāriyāb	99;0	36;45
23	Balkh	101;0	36;41
24	Andarāb	103;45	36;0
25	Badakhshān	104;24	37;10
26	Hazār Asf	95;0	41;0
27	Bukhārā	97;30	39;50
28	Samarqand	99;56	39;37
29	Ṭarāz	99;50	44;31
30	Khujand	100;35	41;55
31	Kāshghar	106;30	44;0

	Place Name *al-bilād*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
32	Khutan	107;0	42;0
33	Quraqūrūm	115;0	46;0
34	Khān Bāligh	124;0	46;0
35	Hurmūz	92;0	25;0
36	Maymand	104;40	35;0
37	Rabāt Amīr	105;0	34;0
38	Daybul	82;30	25;?
39	Nahlawāra	106;0	17;0
40	Mūltān	107;35	29;40
41	Qandahār	107;40	33;0
42	Lahāwar	119;20	31;50
43	Qūz	115;50	26;35
44	Bānārasī	117;20	26;55
45	Sarāndīp	130;0	10;0
46	Tubbat	110;0	40;0
47	Kashmīr	108;0	35;0
48	Ḥaḍrat Dihlī	113;35	28;0
49	Akra	115;0	26;43
50	Kawāliyār	115;0	26;29
51	Ajmīr	111;5	26;0
52	Ujjayn	32;0	22;30
53	Aḥmadābād	103;40	28;55
54	Kābul	104;40	35;0
55	Siyālkūta	109;20	33;0

	Place Name *al-bilād*	**L** *al-ṭūl*	**φ** *al-^{c}arḍ*
56	Pānīpatah	118;20	28;12
57	Jidda	76;0	21;0
58	Bījāpūr	108;30	17;20
59	Mandū	111;25	22;15
60	Kūlkanda	114;50	27;8
61	Bahrūj	109;45	21;20
62	Juyul	106;40	19;0
63	Kanbāyat	109;20	22;20
	Second Circle		
64	^{c}Adan	76;0	11;0
65	Madīnat Rasūl ^{c}Alīyat al-Salām	75;20	25;0
66	Makka Mu^{c}azzam	77;10	21;40
67	Tā’if	77;30	21;20
68	Bayt al-Maqdis	66;30	31;50
69	Ṭarābulus	69;40	34;0
70	Dimashq	70;0	33;15
71	Ba^{c}albak	70;45	33;15
72	Ḥamaṣ	70;45	34;0
73	Ḥalab	72;10	35;10
74	Ṭarsūs	68;40	36;42
75	Malṭiya	71;0	37;0
76	Azran al-Rūm	77;0	39;40
77	Arzinkān	76;0	38;0
78	Sīwās	71;40	39;0

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
79	Qūnya	66;30	41;0
80	Raqah	73;15	36;0
81	ᶜĀna	76;30	34;0
82	Mawṣil	77;0	34;30
83	Arjīs	77;0	38;30
84	Salmās	79;15	37;40
85	Khuway	79;40	37;40
86	Ūrmiya	79;45	37;0
87	Nakhjawān	81;15	38;40
88	Tabrīz	82;0	38;0
89	Ardabīl	82;30	38;0
90	Mūqān	83;0	38;0
91	Bardaᶜa	83;0	40;30
92	Pākīya	84;30	39;30
93	Shamākhī Qaṣba Shirwān	84;30	40;50
94	Bāb al-Abwāb	85;0	43;0
95	Bulghār	90;0	49;30
96	Kūfa	79;30	31;30
97	Madā’in	72;0	33;10
98	Baghdād	80;0	33;25
99	Baṣra	84;0	30;0
100	Rāmhurmūz	85;45	31;30
101	Arḥān	86;30	35;30
102	Fīrūzābād	87;30	28;10

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
103	Shīrāz	88;0	29;36
104	Iṣṭakhr	88;30	30;0
105	Yazd	89;0	32;40
106	Shahrazūr	82;20	32;30
107	Zankān	83;40	36;30
108	Abhar	84;30	36;45
109	Hamadān	83;0	35;10
110	Karaj	84;45	34;0
	Third Circle		
111	Jazīra Mahrāj	150;0	1;0
112	Darqala	63;0	14;30
113	Bajja az Barbar	65;0	14;0
114	Mārbūhūshā	73;0	14;0
115	Mahjam	74;15	17;15
116	Dabīd	74;0	14;10
117	Sharja	74;40	14;50
118	Sūs Aqṣā	15;30	24;0
119	Dargha	21;18	25;10
120	Ajmīm	61;30	27;15
121	Aqṣar	61;40	24;15
122	Maᶜadan Zumurad	66;15	21;0
123	Natmā	67;15	25;40
124	Maᶜadan Dahab	67;35	21;45
125	Asfī	12;15	30;15

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
126	Saṭmāsah	20;0	21;30
127	Marrakish	21;15	29;15
128	Tādlā	22;0	30;15
129	Najrān	77;0	19;15
130	Damār	77;15	13;30
131	Sanᶜā’ dār al-Mulk Yaman	77;0	14;30
132	Sarīn	77;15	20;0
133	Halī bin Yāqūt	77;20	18;30
134	Ẓafār min al-Yaman	77;35	13;20
135	Aydhāb	68;0	21;0
136	ᶜAllāqī	69;0	26;0
137	Qaṣīr	69;0	26;0
138	Qaṭīf	74;0	25;0
139	Qīrwān	41;0	31;40
140	Mahdiya	42;0	32;30
141	Miṣr	63;20	30;20
	Fourth Circle		
142	Ṣāhil Bahr Awqayānūs	11;00	0;0
143	Ghana Maᶜadan al-Dhahab	39;0	10;0
144	Sufālat Azzanj	60;0	2;30
145	Wāsiṭ Bahr Kūrī	63;0	9;0
146	Jarmī Dār al-Mulk Ḥabasha	65;0	9;30

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
147	Zaghāwa	66;0	1;10
148	Hadiya	66;0	2;0
149	Zaylaᶜ	71;0	8;0
150	Muqadishū	72;0	2;0
151	Barbara az Bilād Zanj	78;0	6;30
152	Shibām Qaṣba Haḍramawt	81;15	12;30
153	Mirbāṭ	82;0	12;0
154	Jazīra Lāmrī Maᶜaran al-Bū al-Fūd	137;0	9;0
155	Jabāl Qāmrūn Maᶜadan al-Baqm	135;0	10;0
156	Jazīra Kalah	147;0	8;0

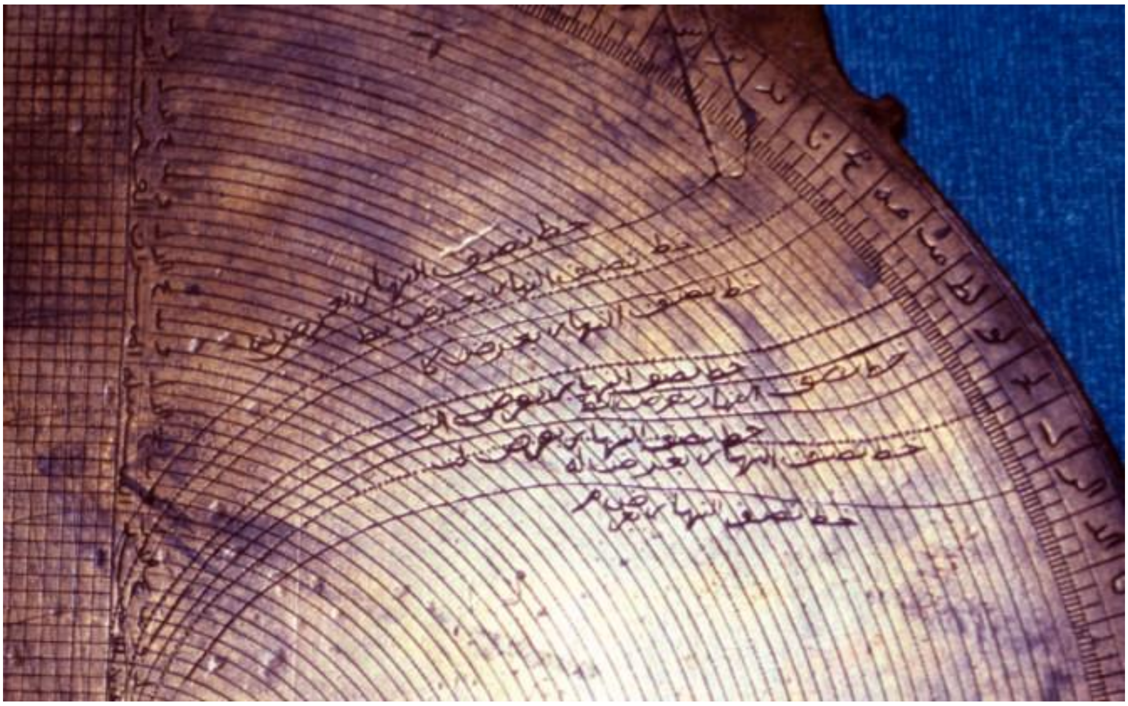

Figure A067.3 – Upper right quadrant with eight curves of the midday altitude of the sun. Note the repair in the altitude scale at the top (photo by S. R. Sarma)

BACK

On the back, the upper half of the rim is divided in 0;20°, 1°, 3° and numbered in 3s as 3—90; 90—3.

In the upper left quadrant is a sexagesimal sine-cosine graph with 60 horizontal and 60 vertical parallels and radial lines at each 6° and also at 45°. There are 9 concentric quarter circles which are at equal distances.

The solar quadrant in the upper right contains declination arcs for each 3° of solar longitude. The names of the corresponding zodiac signs are inscribed along the two radii and the numerical values of the subdivisions are numbered in 6s as 6, 12, 18, 24, 30. Upon these quarter circles are plotted eight curves of the solar meridian altitude for latitudes 15°, 19°, 21°, 27°, 29°, 32°, 35° and 40°.

Figure A067.4 – Lower half of the back (photo by S. R. Sarma)

Shadow squares are drawn in the lower half, on the left for a base of 7 and on the right for 12 and also for 60. The scales are divided and numbered accordingly. In the two inner corners of the squares is the label *ẓill sullam.* The vertical scale on the left is accompanied by the label *aqdām ma*ᶜ*kūs* and the horizontal scale by *aqdām mustawī.* The horizontal scale on the right, divided in 12 digits and 60 parts carries the label *sittaynī wa aṣābi*ᶜ *mustawī* and the vertical scales *sittaynī wa aṣābi*ᶜ *ma*ᶜ*kūs.*

Within the shadow squares are six semi-circular rows containing the names of the 28 lunar mansions, the 12 signs of the zodiac, the table of limits (*ḥudūd*) and the table of decans (*wujūh*).

These semi-circular rows enclose two rectangular tables which are engraved just below the horizontal diameter. On the left is the table called *faḍl al-dawr* (excess of revolution) and on the right is the table of triplicities and their nocturnal and diurnal regents (*arbāb muthallathāth al-layl wa al-nahār*).

The rim of the lower half contains the cotangent scales, on the left in feet (*al-aqdām*) and on the right in digits (*al-aṣābi*ᶜ).

ALIDADE ETC

The original alidade is replaced by a sighting tube of crude workmanship, so also the pin and the horse.

INSCRIPTION

The maker’s signature is engraved in three lines just above the six semi-circular rows containing astrological tables and reads as follows:

> ᶜ*amal ḍiyā’ al-dīn muḥammad ibn mullā qā’im muḥmmad ibn*
> *ḥāfiẓ* ᶜ*īsā ibn shaykh allāhdād*
> *asṭurlābī humāyūnī*
> ‘The work of Ḍiyā’ al-Dīn Muḥammad, son of Mullā Qā’im Muḥammad, son of Ḥāfiẓ ᶜĪsā, son of Shaykh Allāhdād, the astrolabe maker to [the Emperor] Humāyūn.’

The year of manufacture is given in three eras at three different places: below the shadow squares is engraved *sanah 1062 hijrī*; to the east of the shadow square *sanah 1021 qadīmī* and to the west *sanah 1963 rūmī.*

The Hijrī year 1062 is from 13 December 1651 to 30 November 1652.

The Qadīmī year1021 is from 15 October 1651 to 13 October 1652.

The Rūmī year 1963 is from 11 October 1651 to 10 October 1652.

Therefore, the present astrolabe was completed sometime between 13 December 1651 and 10 October 1652.

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Sarma 1996a, pp. 17-20, plates 6-7.

A068⊙ ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1064 AH (AD1653-54)

Diameter 108 mm

Oxford, Museum of the History of Science (# 38862)

CCA 2533; Répertoire 11

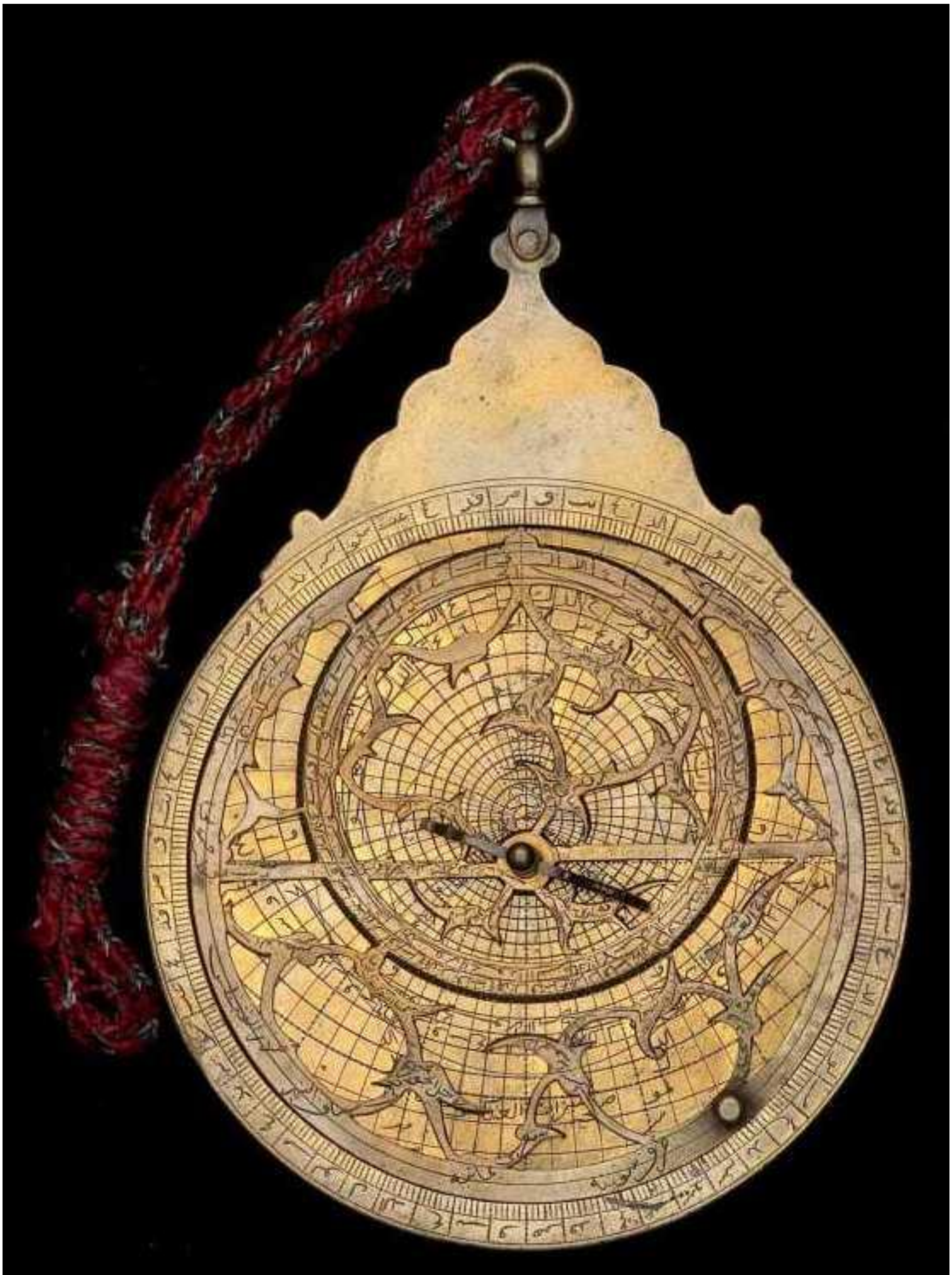

Figure A068.1 – Front of the astrolabe (© Museum of the History of Science, Oxford)

COMPONENTS

Body with *kursī* (d. 108, h. 147, t. 6), shackle, ring and cord, rete (d. 96) for 39 stars, 5 plates (d. 96), alidade, pin and horse.

FRONT

The ring is small with an octagonal cross section; the shackle is trifoliate. To the ring is attached a cord plaited of silver thread and white and red silk. The *kursī* is high and solid with a plain and smooth surface. The profiles are made up of ogees at the base and top with a lobe in between; the finial is trifoliate.

The limb is divided in 6° and 1° and labelled separately for each quadrant as 6—90; 6—90; 6—90; 6—90. Plain lines separate 1° while dotted lines mark 3°.

Figure A068.2 – Rete of the Astrolabe (© Museum of the History of Science, Oxford)

RETE

The two circles of the Tropic of Capricorn and ecliptic are held together by the equinoctial bar which has one counter change at the centre. The ecliptic circle is divided into the 12 signs of the zodiac and labelled with the names of the signs. Each sign is divided into units of 6° and these units are numbered 6, 12, … 30. The edge of the ecliptic circle is graduated in 3°. There is a sturdy handle on the outer ring midway between the north and west points.

The star pointers are joined by an asymmetric arrangement of vines, from which the star pointers emerge like thorns and in a few cases like flowers.

Table A068-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus Janūbī*[373]	β Ceti
2	*Baṭn al-Ḥūt*	β Andromedae
3	*Ṣadr al-Qayṭus*	π Ceti
4	*Kaff al-Jadhmā*	α Ceti
5	*Rās al-Ghūl*	β Persei
6	*Tālī Masāfat al-Nahr*	γ Eridani
7	*ᶜAyn al-Thawr*	α Tauri
8	*ᶜAyyūq*	α Aurigae
9	*Yad al-Jawzā’ Yusrā*	γ Orionis
10	*Rijl al-Jawzā’ Yumnā*	κ Orionis
11	*Shiᶜrā Yamānī*	α Canis Majoris
12	*Shiᶜrā Shāmī*	α Canis Minoris
13	*Tarafat Safīna*	ρ Puppis

[373] The labels of *Dhanab al-Qayṭus Janūbī* and *Dhanab al-Qayṭus Sh[amālī]* are interchanged.

	Star Name	Identification
14	*Fard al-Shujā*[c]	α Hydrae
15	*Qalb al-Asad*	α Leonis
16	*Rās al-Asad*	μ Leonis
17	*Ẓahr dub Akbar*	α Ursae Majoris
18	*Qā*[c]*idat al-Bāṭiya*	α Crateris
19	*Ṣarfa*	β Leonis
20	[c]*Anāq*	ζ Leonis
21	*Janāḥ al-Ghurāb*	γ Corvi
22	*Simāk A*[c]*zal*	α Virginis
23	*Simāk Rāmiḥ*	α Bootis
24	*Kiffa Janūbī*	α Librae
25	*Nayyir Fakka*	α Coronae Borealis
26	[c]*Unuq al-Ḥayya*	α Serpentis
27	*Qalb al-*[c]*Aqrab*	α Scorpii
28	*Rās al-Jāthī*	α Herculis
29	*Rās al-Ḥawwā’*	α Ophiuchi
30	*Yad al-Ḥawwā’ al-Yumnā*	δ Ophiuchi
31	*Nasr Wāqi*[c]	α Lyrae
32	*Minqār al-Dajāja*	β Cygni
33	*Dhanab al-Dajāja*	α Cygni
34	*Dhanab al-Jadī*	δ Capricorni
35	*Sāq Sākib al-Mā’ Janūbī*	δ Aquarii
36	*Dhanab al-Qayṭus Shamālī*	ι Ceti
37	*Mankib al-Faras*	β Pegasi

	Star Name	Identification
38	*Surrat Faras*	δ Pegasi = α Andromedae
39	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are five plates with the following features.

Table A068-2 Plates

	φ	Longest day
1a	22°	13;22 hours
1b	25°	13;35 hours
2a	27°	13;43 hours
2b	29°	13;53 hours
3a	32°	14;8 hours
3b	36°	14;32 hours
4a	0° + 90°	
4b	18° + 72°	
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

On plates 1 to 3, altitude circles are drawn for every 3°, with every fifth line dotted. Azimuth arcs are traced for every 10° below the horizon; those for 30° are dotted and drawn above and below the horizon. There are plain lines for seasonal hours; dotted lines for equal hours from the western and the eastern horizons on plate 1, and from the western horizon on plates 2 and 3.

On plate 4a are combined projections for latitudes 0° and 90°, and on 4b combined projections for 18° and 72°. This plate has notches at the south and north points so that it can be used for both the latitudes engraved on each side.[374]

Plate 5 carries the label *ṣafīḥat mīzān al-ᶜankabūt* on the obverse and *ṣafīḥa āfāqiya* on the reverse.

GEOGRAPHICAL GAZETTEER

The gazetteer is engraved in two concentric circles, with much space between them. The letters are written so that their tops are towards the centre of the plate. The gazetteer commences at the south point, but the argument is engraved to the right of the vertical diameter. Thus the argument is at the end of the row and not at the beginning as is the general practice. The gazetteer contains place names, longitudes and latitudes, in this order, of 46 localities.

Table A068-3 Geographical Gazetteer

	Place Name *asmā’ al-buldān*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
	Outer Circle		
1	Makka Muᶜaẓẓam	77;10	21;40
2	Madīnat Musharrafa	75;20	25;0
3	Miṣr	63;20	30;20
4	Tabrīz	82;0	28;0
5	Bulghār	90;0	49;30
6	Kūfa	79;30	31;30
7	Madā’in	72;0	33;10
8	Baghdād	80;30	33;25

374 In fact, all such plates having double projections ought to have two notches, but it is rarely done. Likewise the tablets of horizons with four sets of half-horizons should have four notches so that all the four sets can be used, but this too rarely done.

	Place Name *asmā’ al-buldān*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
9	Baṣra	84;0	30;0
10	Shīrāz	83;0	29;36
11	Yazd	89;0	32;30
12	Iṣfahān	86;40	32;25
13	Ṭūs	94;30	37;0
14	Balkh	101;0	36;41
15	Bukhārā	97;30	39;50
16	Samarqand	99;59	39;37
17	Hurmūz	92;0	25;0
18	Aḥmadābād	108;0	23;15
19	Ujjayn	112;0	22;30
20	Kābul	104;40	34;30
21	Pānīpatah	113;20	28;52
22	Shāhjahānābād	113;35	28;39
23	Akbarābād	114;0	26;43
24	Ajmīr	111;5	24;0
25	Kawāliyār	114;0	26;0
26	Kashmīr	108;0	35;0
27	Tubbat	110;0	40;0
	Inner Circle		
28	Qannawj	115;50	26;50
29	Lahāwar	109;20	31;50
30	Qandahār	107;40	33;0
31	Mūltān	107;35	29;40

	Place Name *asmā’ al-buldān*	**L** *al-ṭūl*	**φ** *al-ʿarḍ*
32	Tatta	102;30	25;10
33	Jidda	76;0	21;0
34	Pījāpūr	105;30	blank
35	Kalkanda	115;39	18;4
36	Dawlatābād	111;0	20;30
37	Jawnpūr	119;6	26;36
38	Manṣūra Sind	105;0	27;40
39	Kol	114;20	28;4
40	Burhānpūr	109;8	20;31
41	Bahrūj	111;5	21;20
42	Sirhind	111;33	30;30
43	Patna	120;15	26;40
44	Dhaka	130;0	27;0
45	Ilāhābād	112;34	26;50
46	Sūrat	110;50	20;15

BACK

The rim on the upper half carries the altitude scales which are divided in 1° and 6°, and labelled as 6—90; 90—6.

In the upper left quadrant are drawn 30 horizontal parallels, i.e., cosines of 2 of 60 parts of the Radius, with every third line highlighted with dots. Along the vertical radius, these lines are numbered as 6, 12, …60.

In the upper right quadrant are drawn six dotted declination arcs and the related signs of the zodiac are marked by their serial numbers (0 to 11) along the two radii; along the vertical radius, starting from the centre as 3, 4, 5, 6, 7, 8 (Cancer to Sagittarius; i.e., from summer solstice to winter solstice) and along the horizontal radius, starting

from the periphery as 9, 10, 11, 0, 1, 2 (Capricorn to Taurus, i.e. from winter solstice to summer solstice). On this grid are plotted two sigmoid graphs of solar meridian altitude for the latitudes 27° and 32° with the usual labels.

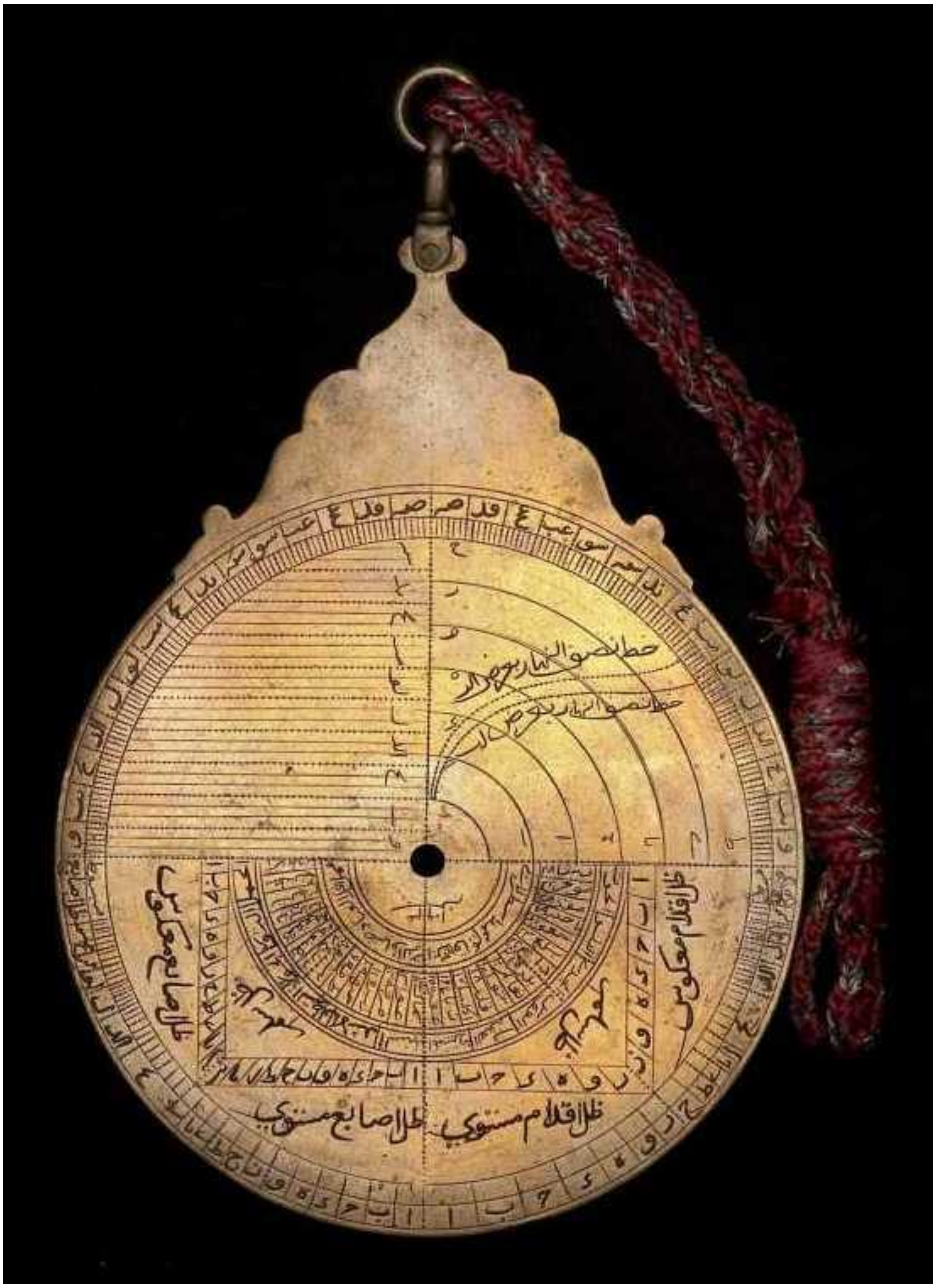

Figure A068.3 – Back of the astrolabe (© Museum of the History of Science, Oxford)

In the lower half are drawn the shadow squares, on the left for a base of 12 digits and on the right for a base of 7 feet. The scales on the left are divided into 12 parts and numbered from 1 to 12; the scales on the right are divided into 7 parts and numbered from 1 to 7. In both the corners, there is an identical legend *ẓill sullam.* The four scales are accompanied by the following labels:

Vertical shadow on the left	*ẓill aṣābi^c ma^{c}kūs*
Horizontal shadow on the left	*ẓill aṣābi^c mustawī*
Horizontal shadow on the right	*ẓili aqdām mustawī*
Vertical shadow on the right	*ẓill aqdām ma^{c}kūs*

Inside the shadow squares, there are two semi-circular rows displaying the correlation between the zodiac signs and the lunar mansions: in the outer row are written the names of the zodiac signs and in the inner semicircle the names of the corresponding 28 lunar mansions.

The rim on the lower half has the cotangent scales and their subdivisions in two consecutive rows. The unequal divisions on the left are numbered as 1, 2, 3, … 12, 18, 24, 30, 36, 42, 48, 54, 60, followed by the label *ẓill aṣābi^c*. In the right half, divisions are numbered in the same manner, but followed by the label *ẓill aqdām.*

ALIDADE

The plain and ungraduated alidade is a replacement. The pin with a lotus-shaped head and the horse with mouth, eyes and mane clearly drawn are original.

INSCRIPTION

The two semi-circular rows of zodiac signs and lunar mansions are followed by a semi-circular panel which carries the astrolabe maker’s signature in an abridged form:

> *^{c}amal aqall al-^{c}ibād ḍiyā’ al-dīn ibn qā’im muḥammad asṭurlābī*
> *sanah 1064*
> ‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn, son of Qā’im Muḥammad, the astrolabe maker; the year 1064 [Hijrī].’

PROVENANCE

Ex. Coll. Nicolas Landau

Coll. J. A. Billmeir, Elstead (Surry)

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Maddison 1957, no. 163, pp. 23-24.

A069 ASTROLABE BY ḌIYĀ AL-DĪN MUḤAMMAD, 1064 AH (AD 1653-54)

Diameter ?

PLU, ex. Habibganj Collection

CCA 1118; Répertoire 12

In his pioneering survey of the Lahore family of astrolabe makers, Nadvi 1935, p. 628, states that an astrolabe by Ḍiyā' al-Dīn Muḥammad was

'in the Library of Nawab Sadar Yar Jung, Maulâna Habîbu'r-Rahmân Khân Sherwânî (Habib Ganj, District Aligarh). The date and inscriptions are thus:

> *ᶜamal aqall al-ᶜibād ḍiyā' al-dīn muḥammad ibn qā'im muḥammad ibn mullā ᶜīsā ibn shaykh allāhdād asṭurlābī humāyūnī lahūrī fī sanah 1064 h*
>
> 'The work of the humblest creature Zîa'u'd-dîn Muḥammad, son of Qâim Muḥammad, son of Mullâ 'Isâ, son of Sheykh Allâh-Dâd, Astrolâbî , Humâyûnî, Lahôrî, in 1064 A.H.)'

A large collection of manuscripts and historical artefacts belonging to this family was gifted to Aligarh Muslim University in 1960; this collection is now well known as the 'Habibganj Collection' in the Maulana Azad Library of Aligarh Muslim University. The astrolabe, however, did not reach Aligarh Muslim University, nor was it with the family. It disappeared somewhere in the process of transfer and since then there has been no trace of it.

Besides the text of the signature and the year of production provided by Nadvi, no other details about this astrolabe are available.

A070 ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1064 AH (AD 1653-54)

Diameter 103 mm

PLU: ex-London, Sotheby’s (Catalogue 1 April 2009, lot 102)

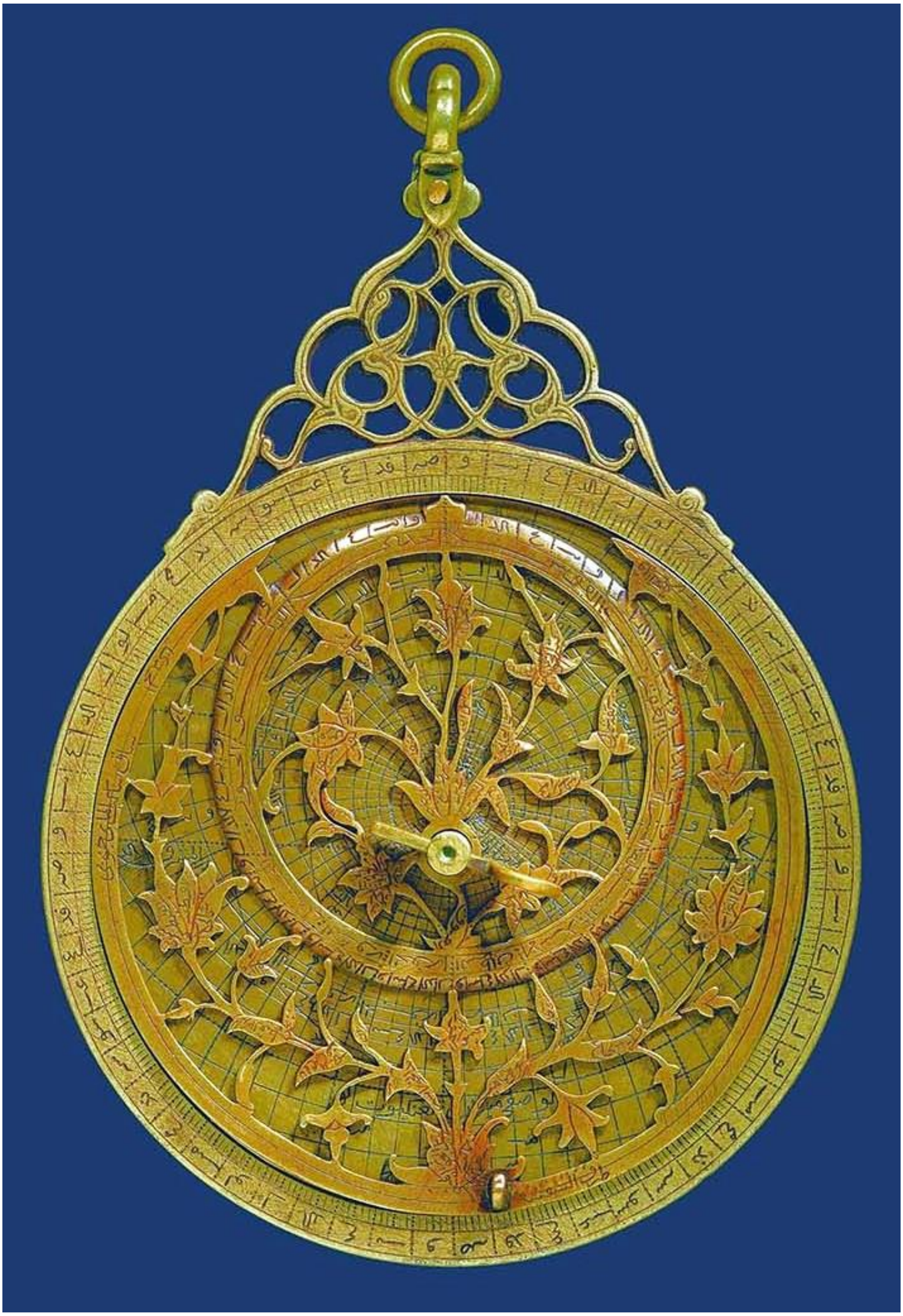

Figure A070.1 – Front of the astrolabe (© Sotheby’s, London)

COMPONENTS

Mater with *kursī* (d. 103, h. 160), shackle and ring, rete, 4 plates, alidade, pin and horse.

FRONT

Simple ring, trifoliate shackle, and finely reticulated *kursī.* The profiles with ogees with a lobe in between and topped by a trifoliate finial stand out as a frame around a design with three-petalled flower at the centre. The limb is graduated in 1° and 6°, and labelled in 6s from 6 to 90 separately in each quadrant as 6—90; 90—6; 6—90; 90—6.

RETE

Unusually the equinoctial bar is not represented in the rete. The rings of Capricorn and ecliptic are held together by the floral tracery which joins the star pointers. The tracery between the two rings is like a realistic flowering bush branching off to the left and right with large leaves and flowers. The tracery inside the ecliptic ring represents a smaller bush arising from the central ring with its branches spreading all around.

The ecliptic ring is divided into the 12 signs of zodiac and labelled with their names; each sign is further subdivided into groups of 6° and numbered accordingly.

Figure A070.2 – Rete of the astrolabe (© Sotheby’s. London)

PLATES

There are four plates. Obverse sides of three plates serve the latitudes of 32°, 34° and 36°. It is not known which latitudes are served by the other sides of these three plates. On the back there are curves for the midday altitude of the sun at latitudes of 27° and 32°. Therefore there should be two plate faces serving the latitudes 27° and 32°. The sixth plate face appears to carry a double projection of two latitudes. The fourth plate carries the tablet of ecliptic coordinates on one side and the tablet of horizons on the other.

GEOGRAPHICAL GAZETTEER

There is a gazetteer for 54 localities in Greater Iran and India.

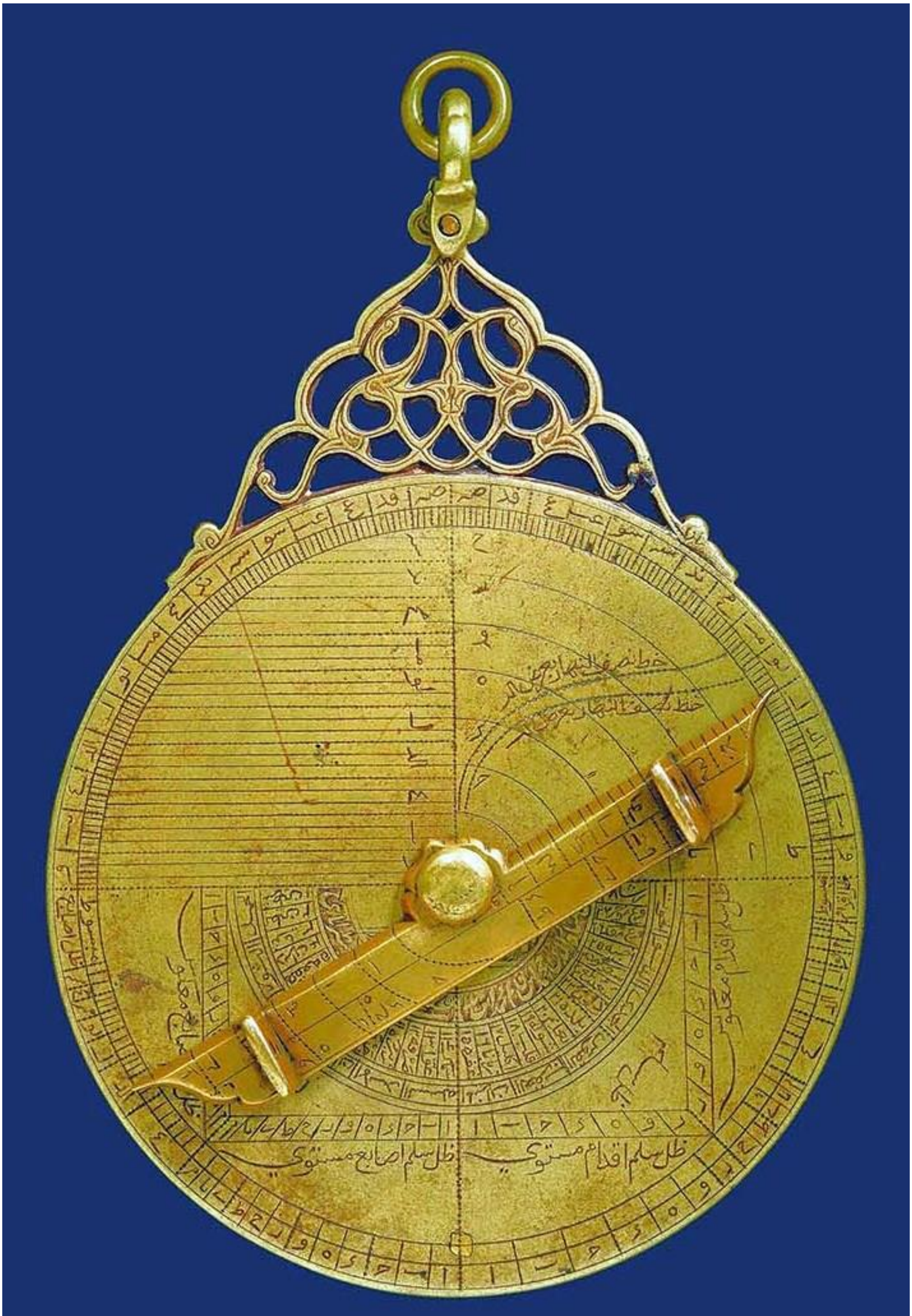

Figure A070.3 – Back of the astrolabe (© Sotheby’s, London)

Back

The rim of the upper half carries the altitude scales divided in 1° and 6°, and labelled as 6—90; 90—6, while the rim of the lower half bears the cotangent scales in feet and digits.

There is a trigonometric grid in the upper left with 30 horizontal parallel lines; these are numbered in 6s along the vertical radius. In the upper right is the solar quadrant which is divided by declination circles into six zones, each representing a pair of zodiac signs. The signs are marked by their serial numbers along the two radii. Two dotted sigmoid curves are traced in this quadrant for the midday altitude of the sun throughout the year at the two latitudes of 27° and 32° with the usual labels.

In the lower half there are shadow squares for 12 digits on the left and 7 feet on the right with the usual labels. Inside the shadow squares are three semi-circular rows. The outermost is engraved with the names of the 12 zodiac signs and the middle one with the names of the 28 corresponding lunar mansions along with their serial numbers.

Alidade

The alidade has ornate ends with sharply pointed tips and an ornate centre-piece with five lobes. It carries on the right hand side a sexagesimal scale in the upper register and a scale of unequal hours in the lower register; on the left, it is marked with a zodiac scale and the serial numbers of the signs.

Inscription

Inside the shadow squares, the innermost semi-circular row and a horizontal row are engraved with the astrolabe-maker’s signature and the date of manufacture of the astrolabe in embossed letters.

> *ᶜamal ḍiyā’ al-dīn muḥammad ibn qā’im muḥammad ibn mullā ᶜīsā ibn shaykh allāhdād asṭurlābī humāyūnī lāhūrī fī sanah 1064 hijrī.*
>
> ‘The work of Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1064 Hijrī [= AD 1653-1654].’

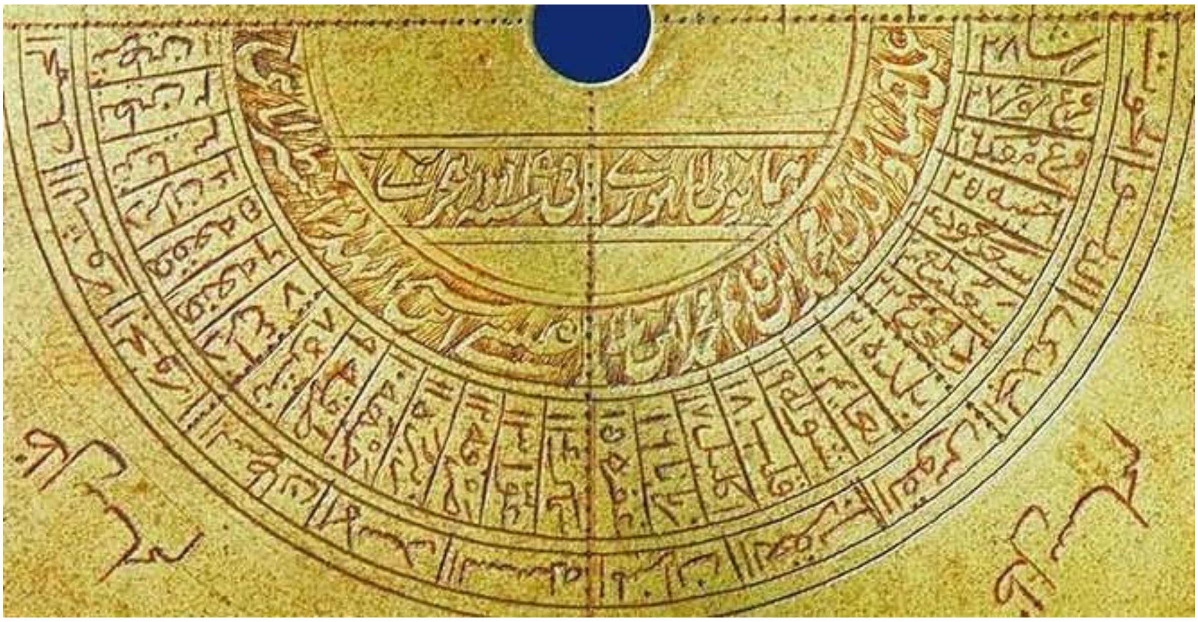

Figure A070.4 – Astrological table and the signature of the astrolabe maker (© Sotheby’s, London)

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A071⊙ ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1064 AH (AD 1653-54)

Diameter 63.5 mm

Cologne, PC

Figure A071.1 – Front of the astrolabe (photo by the owner)

It is one of the smallest astrolabes. Ḍiyā’ al-Dīn himself made yet a smaller astrolabe with a diameter of 52 mm in 1074/1663-64, but of it only the mater survives (A083). His uncle Muḥammad Muqīm made a still smaller astrolabe with a diameter of 45mm (A050), but in this astrolabe, the rete, alidade, one plate, pin and horse are not original, while all the parts in Diya’s astrolabe are original, except for the horse. Despite the small size, all the numbers and letters are engraved distinctly on the present astrolabe. Indeed, it is a real jewel with all the miniature components meticulously crafted.

COMPONENTS

Mater (d. 63.5, h. 90, t. 4.5) ring, shackle, rete for 23 stars, 5 plates, alidade, pin and wedge. Wedge is a crude modern replacement.

FRONT

The *kursī* is large; it is elegantly reticulated with a trifoliate ornament in the middle; the profiles are made up of ogees at the base and at the top with a lobe in the middle; there are decorative lines on the surface on the front as well as on the back. The finial is trifoliate, so also the shackle. The ring is large. The rim is divided in 2° and 6° and labelled clockwise in 6s, from 6 to 90, separately in each quadrant.

RETE

In the rete, the Capricorn ring and the ecliptic ring are held together by the equinoctial bar which has three counter changes. The solstitial bar is partly shown above and below the ecliptic ring. The ecliptic ring is divided by dotted lines into the 12 signs of the zodiac and labelled with their names. Each sign is divided into 5 units, and the divisions are marked on the edge of the ecliptic, but not numbered. A knob to turn the rete is affixed on the Capricorn ring, about 40° to the east of the north point. There is triangular Capricorn index.

There are 23 star pointers which are joined by an almost symmetric tracery. Two star names (nos. 6 and 12) engraved near the centre appeared to have been worn off and cannot be clearly deciphered.

Figure A071.2 – Rete of the astrolabe (photo by Ananda Sarma)

Table A071-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus [Janūbī]*	β Ceti
2	*Fam al-Qayṭus*	γ Ceti
3	*Ṣadr al-Qayṭus*	π Ceti
4	*Masāfat al-Nahr*	γ Eridani
5	*ᶜAyn al-Thawr*	α Tauri

	Star Name	Identification
6	*[ᶜAyyūq]*[375]	α Aurigae
7	*Yad al-Jawzā’ al-Yumnā*	α Orionis
8	*Shᶜirā Yamānī*[376]	α Canis Majoris
9	*Shᶜirā Shāmī*	α Canis Minoris
10	*Rās al-Taw’am al-Muqaddam* (?)	α Geminorum
11	*Qāᶜidat al-Bāṭiya*	α Crateris
12	*Ẓahr [al-Dubb al-Akbar]* (?)	α Ursae Majoris
13	*Simāk Aᶜzal*	α Virginis
14	*Kiffa Janūbī*	α Librae
15	*ᶜUnuq al-Ḥayya*	α Serpentis
16	*Rās al-Jāthī*	α Herculis
17	*Nasr Wāqiᶜ*	α Lyrae
18	*Nasr Tā’ir*	α Aquilae
19	*Dhanab al-Jadī*	δ Capricorni
20	*Fam al-Faras*	ε Pegasi
21	*Mankib al-Faras*	β Pegasi
22	*Sāk Sākib al-Mā’ J[anūbī]*	δ Aquarii
23	*Dhanab al-Qayṭus [Shamālī]*	ι Ceti

375 The name is completely rubbed off.

376 The name is engraved on the Capricorn ring; but the star pointer, curved like a tiger’s claw, is above.

Figure A071.3 – The plates (row 1: rete and the tablet of ecliptic coordinates;
row 2: plate for latitude 40°and plate for latitude 27°;
row 3: plate for latitude 32° and plate for 22°)
(photo by Ananda Sarma)

Figure A071.4 – Reverse sides of the plates (row 1: reverse of the rete and the tablet of horizons; row 2: plate for latitude 36°and plate for latitude 29°; row 3: plate for latitude 34° and plate for 24°) (photo by Ananda Sarma)

PLATES

There are five plates. On all plates the circles of the two tropics and equator are drawn; the horizontal and vertical diameters are marked with dotted lines.

Table A071-2 Plates

	φ	Longest day
1a	22°	13;22 hours
1b	24°	13;35 hours
2a	27°	13;43 hours
2b	29°	13;52 hours
3a	32°	14;8 hours
3b	34°	14;20 hours
4a	36°	14;32 hours
4b	40°	14;54 hours
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

Plates 1 to 4 serve latitudes from 22° to 40°. Here altitude circles are traced for every 6° and numbered on both sides of the meridian; every fifth altitude circle is highlighted with dots. Azimuth arcs are drawn below the horizon for every 10° and numbered in a straight line parallel to the horizontal diameter; azimuth arcs for every 30° are drawn both above and below the horizon and the lower part is highlighted with dots. In the lower half, there are plain lines for seasonal hours which are numbered from the western horizon to the eastern, above the circle of equator. Equal hours are indicated by dotted curves which are drawn from the western horizon; these are also numbered from the western horizon to the eastern, a little above the circle of Capricorn.

The value of the latitude and the duration of the daylight hours are engraved at the middle of the plate. Below the oblique horizon are the labels *al-mashriq* in the east and *al-maghrib* in the west.

The obverse side of the fifth plate carries the projections for the latitude of 66;30°. Here the horizon coincides with the ecliptic and the zenith with the ecliptic pole. On this plate, latitude circles are drawn for every 6°, from 6° to 90° N and from 6° to 48° S. These are numbered on either side of the meridian. Every fifth circle, representing 30°, is dotted. The circles of longitude, radiating from the zenith, are traced for every 10°. These are numbered as 10, 20, 30, separately in each zodiac sign. Every third of these, representing the boundaries between the signs of the zodiac, are dotted. The names of the six signs from *al-Ḥamal* to *al-Sunbula* are engraved outside the ecliptic circle in the lower half of the plate. The names of the remaining six signs from *al-Mīzān* to *al-Ḥūt* are engraved inside the ecliptic circle in the upper half of the plate. Finally, the designation of the plate *Ṣafīḥat Mīzān al-ᶜAnkabūt* is engraved between the horizon and the north point.

On the reverse side of this plate are traced four sets of half-horizons for latitudes from 6° to 66° at intervals of 8° in the following manner:

6	14	22	…	46	54	62
8	16	24	…	48	56	64
10	18	26	…	50	58	66
12	20	28	…	52	60	

The latitude values are engraved at the beginning and end of each half-horizon. Declination scales drawn along the four radii between the equator and the two tropics. The scales are divided in 3° and 6° and numbered in 6s from 6 to 24. The name of the plate *ṣafīḥa āfāqī* is written in large letters. This plate should have four notches at the four cardinal points so that the four sets of half-horizons can be made use of. But there is a notch only at the north point as in all other plates.

Figure A071.5 – Geographical Gazetteer (photo by Ananda Sarma)

Geographical Gazetteer

The inner side of the mater bears the geographical gazetteer of 15 localities with their longitudes and latitudes.

Table A071-3 Geographical Gazetteer

	Place Name *asmā’ al-buldān*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
1	Makka Muᶜaẓẓam	77;10	21;40
2	Madinat Musharrafa	75;20	25;0
3	Yazd	89;0	32;30
4	Iṣfahān	86;40	32;25
5	Bukhārā	94;30	39;50
6	Balkh	101;0	36;41
7	Kābul	104;40	34;30
8	Qandahār	107;40	33;0
9	Multān	104;35	29;40
10	Kashmīr	103;0	35;0
11	Lahāwar	109;20	31;50
12	Shāhjahānābād	113;35	28;39
13	Ajmīr	111;5	26.0
14	Akbarābād	115;0	26;46
15	Burhānpūr	109;0	20;31

Figure A071.6 – Back of the astrolabe (photo by the owner)

BACK

The rim of the upper half carries the altitude scales divided in 2° and 6° and numbered in 6s as 6—90; 90—6. In the upper left is the trigonometric quadrant with 20 horizontal parallels, alternate lines are dotted and numbered in 6s along the vertical radius from 6 to 60. In the upper right is the solar quadrant which is divided in 6

segments by 5 quarter circles. The related zodiac signs are marked by serial numbers along the two radii. Along the vertical radius from the centre to the periphery are the numbers 3, 4, 5, 6, 7 and 8 (i.e., from the summer solstice to the winter solstice) and along the horizontal radius from the periphery to the centre are the numbers 9, 10, 11, 0, 1 and 2 (i.e., from the winter solstice to the summer solstice). Two dotted curves of the solar meridian altitude at latitudes 29° (Delhi) and 32° (Lahore) are superimposed in this quadrant with labels *khaṭṭ niṣf al-nahār bi-^{c}arḍ* 29 and *khaṭṭ niṣf al-nahār bi-^{c}arḍ* 32 respectively.

In the lower half are shadow squares, on the left for a base of 6 and 12, and on the right for a base of 7. The scales on both sides are divided and numbered accordingly. The four scales carry the following labels.

Vertical scale on the left:	*ẓill aṣābi^{c} ma^{c}kūs*
Horizontal scale on the left:	*ẓill aṣābi^{c} mustawī*
Horizontal scale on the right:	*ẓill aqdām mustawī*
Vertical scale on the right:	*ẓill aqdām ma^{c}kūs*

The rim on the lower half is engraved with cotangent scales. The unequal divisions on the scale on the left are numbered clockwise from the meridian as 1, 2, 3, 4, 5, 6, 8, 10, 12, 18, 24, 30, 36, 42, 48, 60 and followed by the label *ẓill aṣābi^{c} mabsūt.*

The unequal divisions on the scale on the right are numbered counter-clockwise from the meridian as 1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 18, 24, 30, 36, 42 and followed by the label *ẓill aqdām mabsūt.* Inside these cotangent scales, there are two semi-circular rows engraved with the names of the 12 zodiac signs and the names of the corresponding 28 lunar mansions.

ALIDADE ETC

The alidade is endowed with ornate ends and an ornate centre-piece. The upper register on the right hand side carries a scale numbered in 6s from the centre to the tip as 6, 12, 18 … 60. The edge is divided in groups of 3 units. This scale matches with the divisions of the vertical radius of the upper left quadrant.

The lower register on the right has unequal divisions numbered from 1 to 6 from the sighting plate onwards and again numbered from 7 to 12 in the reverse direction. When the alidade is used as sundial with the sighting plate on the right as the gnomon,

the shadows thrown by the sighting plate across the length of the alidade are measured on this scale.

The left arm of the alidade is engraved with declination arcs together with six pairs of signs marked by their serial numbers as in the upper right quadrant.

The pin has a broad round head. The wedge is a crude replacement.

Figure A071.7 – Alidade (photo by S. R. Sarma)

INSCRIPTION

In the space below the shadow squares and above the semicircular scales is the maker’s inscription:

> *ᶜamal aqall al-ᶜibād ḍiyā’ al-dīn muḥammad fī sanah 1064 hijrī*
>
> ‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn Muḥammad, in the year 1064 Hijrī.’

The year corresponds to 1653-54.

A072⊙ ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1067 AH (AD 1656-57)[377]

Diameter 308 mm

Jaipur, Jai Singh’s Observatory

CCA 75=2702; Répertoire 14

Figure A072.1 – Front of the astrolabe (photo by S. R. Sarma)

377 I had the privilege of accompanying Professor David King when he examined this astrolabe in 1991. This description is partly based on his notes. I copied the gazetteer on a subsequent visit.

This is an exquisitely crafted astrolabe; probably the largest standard astrolabe made by Ḍiyā’ al-Dīn, second only to his huge *Zarqālī* universal astrolabe (A091). Both these and several other Mughal astrolabes were acquired by Jai Singh and were in his personal collection. In his work *The Astronomical Observatories of Jai Singh,* G. R. Kaye refers to this astrolabe as ‘Jaipur B’. This and an equally large zoomorphic astrolabe, which is unsigned but can be attributed to Ḍiyā’ al-Dīn’s uncle Muḥammad Muqīm (A051), which Kaye designates as ‘Jaipur A’, formed the basis for Kaye’s pioneering discussion of the construction and use of the astrolabe in the book mentioned above (pp. 17-26).

Figure A072.2 – The *kursī* of the astrolabe (photo by S. R. Sarma)

COMPONENTS

Body with *kursī* (d. 308, h. 410, t. 10), shackle and ring, rete (d. 285) for 52 stars, 5 plates (d. 285), alidade, pin and horse.

FRONT

The ring is massive with an octagonal cross section and the shackle is equally massive in trifoliate form also with an octagonal cross section. The profiles of the *kursī* are formed by two lobes between ogees below and above and topped by a trifoliate finial. Framed inside the ornately engraved rim is an arrangement of five flowers and buds and leaves. The limb is graduated in 0;20°, 1° and 5° and labelled in 5s from 5 to 360. The

abjad numbers are embossed in relief inside a small cartouche against a finely hatched background. The edge is also decorated with ornate cartouches in which some poem is inscribed in letters embossed in relief.

Figure A072.3 – Rete of the astrolabe (photo by S. R. Sarma)

RETE

This is perhaps the most beautiful rete crafted by Ḍiyā’ al-Dīn and looks like the floral compositions in *pietra dura* on the walls of the Taj Mahal. The two broad rings of the Tropic of Capricorn and the ecliptic are held together by the slender equinoctial bar which has counter changes at its two intersections with the ecliptic. The space inside these rings is filled with a tracery which resembles flowering plants. From the north point on the peripheral ring arises one plant and spreads its thin branches, full of flowers

and leaves, to the left and to the right and upwards as it crosses the ecliptic ring and reaches up to the central ring. From the central ring rises another plant and spreads inside the ecliptic ring. The tips of some of these leaves and flower petals constitute the pointers to the stars whose names are engraved on the leaves and petals.

The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names in embossed letters against a finely hatched background. Each sign is divided into groups of 6° and numbered from 6 to 30. The units are further subdivided into single degrees on the edge of the ecliptic ring.

Table A072-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus J[anūbi]*	β Ceti
2	*Baṭn al-Ḥūt*	β Andromedae
3	*Rijl al-Musalsala*	γ Andromedae
4	*Fam al-Qayṭus*	γ Ceti
5	*Ṣadr al-Qayṭus*	π Ceti
6	*Rās al-Ghūl*	β Persei
7	*Mirfaq al-Thurayyā*	α Persei
8	*Tālī Masāfat al-Nahr*	γ Eridani
9	*ᶜAyn al-Thawr*	α Tauri
10	*Al-ᶜAyyūq*	α Aurigae
11	*Rijl Jawzā’ Yusrā*	β Orionis
12	*Yad Jawzā’ Yusrā*	γ Orionis
13	*Yad Jawzā’ Yumnā*	α Orionis
14	*Rijl Jawzā’ Yumnā*	κ Orionis
15	*Shiᶜrā Yamānī*	α Canis Majoris
16	*Shiᶜrā Shāmī*	α Canis Minoris

	Star Name	Identification
17	*Rās al*-xw’xi??	?
18	*Nathra Saḥābi*	ε Cancri
19	*Fard al-Shujā*ᶜ	α Hydrae
20	*Qalb al-Asad*	α Leonis
21	*Rās al-Asad*	μ Leonis
22	*Ẓahr Dubb Akbar*	α Ursae Majoris
23	*Qā*ᶜ*idāt al-Bāṭiya*	α Crateris
24	*Ẓahr al-Asad*	δ Leonis
25	*Janāḥ al-Ghurāb*	γ Corvi
26	*Al-Ṣarfa*	β Leonis
27	ᶜ*Anāq*	ζ Ursae Majoris
28	*Simāk A*ᶜ*zal*	α Virginis
29	*Simāk Rāmiḥ*	α Bootis
30	*Kiffa Sh[amālī]*	β Librae
31	*Nayyir Fakka*	α Coronae Borealis
32	ᶜ*Unuq al-Ḥayya*	α Serpentis
33	*Rukbat al-Ḥawwā’ al-Yusrā*	ζ Ophiuchi
34	*Rās al-Jāthī*	α Herculis
35	ᶜ*Ayn al-Tinnīn*	γ Draconis
36	*Rās al-Ḥawwā’*	α Ophiuchi
37	*Yad al-Hawwā’ al-Yumnā al-Muqaddam*	ρ Ophiuchi
38	*Nasr Wāqi*ᶜ	α Lyrae
39	ᶜ*Usana al-Rāmi*	?

	Star Name	Identification
40	*Minqār al-Dajāja*	β Cygni
41	*Nasr al-Ṭā’ir*	α Aquilae
42	*Dhanab al-Dulfīn*	ε Delphini
43	*Dhanab al-Dajāja*	α Cygni
44	*Dhanab al-Jadī*	δ Capricorni
45	*Fam al-Faras*	ε Pegasi
46	*Mankib Sāqib al-Mā’*	α Aquarii
47	*Sāq Sāqib al-Mā’*	δ Aquarii
48	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
49	*Mankib al-Faras*	β Pegasi
50	*Surrat al-Faras*	δ Pegasi
51	*Janāḥ al-Faras*	γ Pegasi
52	*Kaff al-Khadīb*	β Cassiopeiae

PLATES

There are five plates. On the first four plates, altitude circles are drawn for every 1° with each sixth highlighted with dots. Azimuth lines are drawn for every 6°, below the horizon on plates 1, 3 and 4 and above and below the horizon on plate 2. Lines for seasonal hours are numbered in *abjad* numerals. Dotted lines are drawn for *ghaṭīs* and numbered in common Arabic/Persian numerals. On plate 1, these are drawn both from the western and eastern horizons and numbered from 1 to 16 from each horizon up to the meridian. On plates 2, 3 and 4 these are drawn from the western horizon and numbered from there from 1 to 35. Because two and half *ghaṭīs* (of 24 minutes each) make one hour (60 minutes), *ghaṭīs* numbered 3, 8, 13, 18, 23, 28 are divided into two parts to synchronize with the equal hours. Thus from these lines time can be measured

in both the *ghaṭīs* and equal hours, for 2 ½ gh = 1h; 5 gh = 2 h, 7 ½ gh = 3 h; 10 gh = 4 h; 12 ½ = 5 h, and so on.

On all these plates, i.e., 1 to 4, the maximum duration of the daylight at the relevant latitude is given in hours and minutes and also in *ghaṭīs* and *palas.* These units are inscribed as *karī-hā* and *pala-hā (hā* plural particle). However, certain *ghaṭī* values are not correct. The following table shows the *ghaṭī* values as engraved on the plates in column 3 and the correct values in column 4.

Table A072-2 Plates

	φ	Maximum duration of the daylight hours	 *ghaṭīs*	 correct *ghaṭīs*
1a	22°	13;21	33;22	33;22,30
1b	25°	13;35	33;57	33;32,30
2a	27°	13;43	34;17	34;27,30
2b	29°	13;52	34;40	correct
3a	32°	14;8	35;20	correct
3b	34°	14;20	35;50	correct
4a	36°	14;32	36;20	correct
4b	38°	14;43	36;47	36;47,30
5a	Tablet of horizons			
5b	Tablet of ecliptic coordinates			

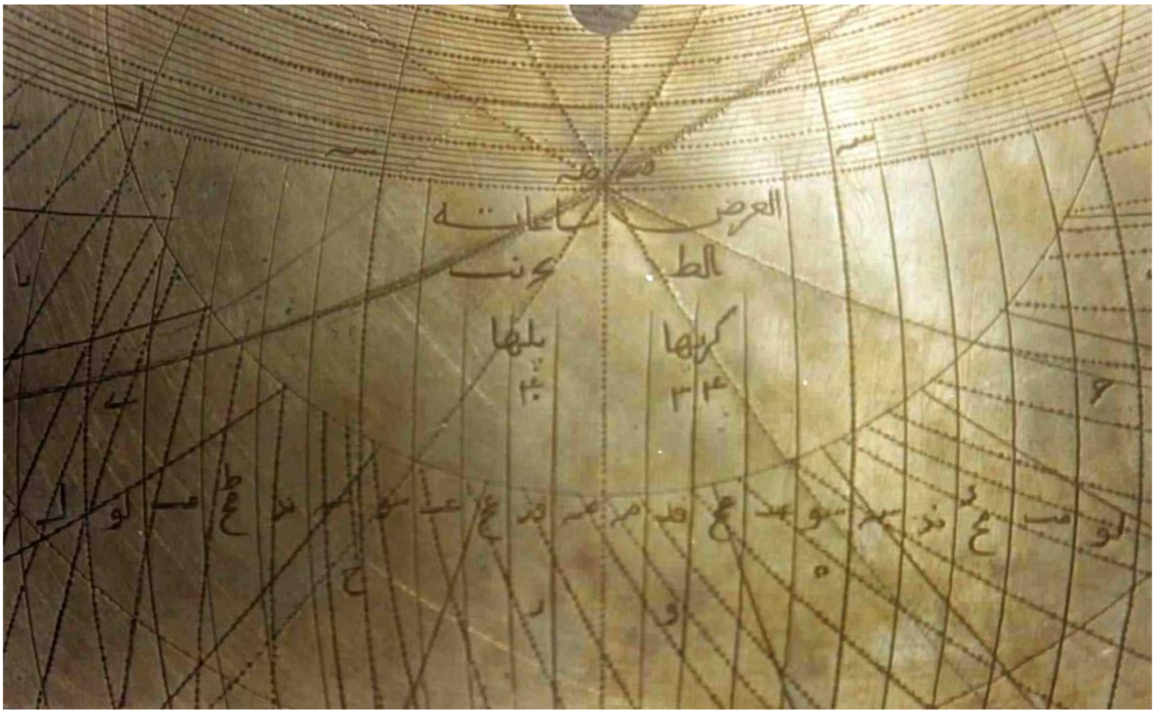

Figure A072.4 – Plate 2b for latitude 29°. Note the *ghaṭī* values at the centre and the lines for equal hours and for ½ *ghaṭīs* below. (photo by S. R. Sarma)

In 5a, half-horizons are drawn for every 1° from 1° to 90°. Along the radii are declination scales with the divisions marked as 3, 6, 9, 12, 15, 18, 21, 23;30 and labels *taqsīn mayl kullī shamālī* or *janūbī,* ‘division of the maximum declination north’ or ‘south’.

Geographical Gazetteer

On the inner side of the mater is engraved a geographical gazetteer with the names, longitudes and latitudes of 210 localities in six concentric circles. Here the localities are arranged according to regions, starting from the Maghreb in the west and reaching up to Sind and Hind in the east. Only two other Lahore astrolabes follow this arrangement and both of them are by Ḍiyā’ al-Dīn (A062 and A093). About this gazetteer, Kaye remarks as follows:

> The list of names on ‘Jaipur B’ (figure 13) is interesting as being copied from Ulugh Beg’s table … The number of towns is the same, but the astrolabe designer left out some of the western places [e.g., those in the country of Rum and some of those of Shām (Syria)], and added some extra towns for

India. Otherwise the names, the order and the latitudes and longitudes are the same.[378]

Kaye is not quite right in saying that ‘the number of towns is the same’ because Ulugh Beg’s table has 278 localities while the present astrolabe has just 210 localities.[379] Otherwise Kaye is right: the names, the order and the latitudes and longitudes are the same. But there is one problem which Kaye did not notice. The headings mentioning the regions are slightly shifted on the astrolabe with the result that Bajjah az Barbar (008) is placed in Andalus and not in Sudan where it rightly belongs, Suez (015) is mentioned under Yemen and not under Egypt and so on. This shift in the headings could not have been due to the carelessness of the engraver, for it occurs also in two other astrolabes by Ḍiyā’ al-Dīn. It must have occurred already in the source manuscript/s used by Ḍiyā’ al-Dīn.

In the table below the headings are retained as they are engraved on the astrolabe. The correct positions according to the Ulugh Beg’s table are mentioned in footnotes. We have added modern names wherever it is possible.

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378 Kaye 1918, p. 26.

379 Cf. Sédillot 1853, pp. 257-271; see also Kennedy 1987a, pp. 560-564 where the entries are arranged alphabetically.

Figure A072.5 – The geographical gazetteer, upper half, placed upside-down to facilitate easy reading (photo by S. R. Sarma)

Figure A072.6 – Geographical gazetteer, lower half (photo by S. R. Sarma)

Table A072-3 Geographical Gazetteer

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	Identification/ Modern Name
	First Circle			
Iqlīmhā Maghrib[380] (the region of the Maghreb)				
1	Sūs Aqṣā	15;30	32;0	Sus al-Aksa, Morocco
2	Fārs Qaṣbah Tanjah[381]	18;00	22;0	Fez, Morocco
3	Tāhart ᶜŪliyā’	35;30	29;0	Upper Tahart
4	Tāhart Suflī az Afrīqah	36;0	29;0	Lower Tahart in Africa
5	Mahadiyya	42;0	32;30	Mahdiya, Tunisia
6	Ṭarābulus Maghrib	45;0	32;0	Tripoli, Libya
Andalus (Andalusia)				
7	Qurṭaba Dār al-Mulk Andalus	38;26	35;0	Cordova, Spain
8	Bajja az Barbar[382]	65;0	14;0	Beja, Sudan
Sūdān (Sudan)				
9	Jarmī Dār al-Mulk Habasha	65;0	9;30[383]	Jarmi, capital of Abyssinia
10	Durqula Shahr Nūbah	53;40	14;30	Dunqula, town in Nubia

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380 Ulugh Beg, Maghrib

381 The correct name is Fas. Ulugh Beg gives the latitude as 32° which is the correct value.

382 It is wrongly included in Andalus; it belongs to the next region Yemen.

383 Ulugh Beg 9;0.

	Place Name (*asmā’ al-buldān*)	**L (*al-ṭūl*)**	**φ (*al-ᶜarḍ*)**	**Identification/ Modern Name**
Miṣr (Egypt)				
11	Qūṣ az Qaṣbah Miṣr[384]	61;30	24;30	Qus, Egypt
12	Iskandariyya	61;54	30;58	Alexandria, Egypt
13	Miṣr	63;20	30;20	Cairo, Egypt
14	Dumyāṭ	63;30	31;25	Damietta, Egypt
Yaman (Yemen)				
15	Qulzum az Kanār Darya[385]	64;0	29;30	Suez on the Red Sea, Egypt
16	ᶜAdan	76;0	11;0	Aden, Yemen
17	Ṣanᶜā’ Dār al-Mulk Yaman	77;0	14;30	Sanaᶜa, Yemen
Hijāz (Hejaz, western part of Saudi Arabia on the coast of the Red Sea)				
18	Madīnat Rasūl ᶜAlīyat al-Salām	75;20	25;0	Medina, Saudi Arabia
19	Makka Mubārak	77;10	21;40	Mecca, Saudi Arabia
20	Ṭāᶜif	77;30	21;20	Taif, Saudi Arabia
Bahrayn (Bahrain)				
21	Yamāma[386]	82;30	23;30	Al-Yamama, Saudi Arabia
22	Hajar Baḥrayn	83;0	25;0	Al-Hajar, Bahrain

[384] Ulugh Beg has ‘Qūs az Saᶜīd Aᶜūlia.’

[385] Qulzum should be placed in Egypt.

[386] It should be in Hejāz.

	Place Name (*asmā’ al-buldān*)	**L (*al-ṭūl*)**	**φ (*al-ᶜarḍ*)**	**Identification/ Modern Name**
23	Ḥasā Jazīra	83;30	24;0	Al-Ahsa = Hofuf, Saudi Arabia
24	Qaṭīf Bahrayn	75;0	25;0	Qatif, Saudi Arabia
Shām (Syria)				
25	Bayt al-Maqdis az Filisṭīn	66;30	31;50	Jerusalem, Israel
26	Ṭarābulus	69;40	34;0	Tripoli, Lebanon
27	Dimashq	70;0	33;15	Damascus, Syria
28	Baᶜalbak	70;15	33;15	Baalbek, Lebanon
29	Anṭākiya az Thaghūr	71;26	35;30	Antioch = Antakya, Turkey
30	Ḥalab	72;10	35;30	Aleppo, Syria
31	Ṭarṭūs	68;40	34;10	Tarsus, Turkey
Thughūr Rūm (the border lands of the Byzantines)				
32	Rūmiya Kabrī	85;27	41;50	The Grand Rome, Italy
33	Arz ar-Rūm	72;0	39;40	Erzurum, Turkey
34	Arzankān	76;0	38;0	Erzincan, Turkey
35	Sīwās	71;40	39;0	Sivas, Turkey
36	Sīmsāṭ	72;35	40;0	Samsat, Turkey
37	Qālīqalā	73;25	39;0	near Erzurum, Turkey
Jazīra (the region of ancient Mesopotamia)				
38	Ḥarrān az Jazīra	73;0	36;40	Harran, Turkey
39	Rās Alᶜaīn	74;0	36;50	Ras Alayn, Syria
40	Mārdīn	74;0	37;15	Mardin, Turkey

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	Identification/ Modern Name
41	Niṣībīn	75;20	37;0	Nisibin on Euphrates
42	ᶜĀna	76;30	34;0	Ana, on Euphrates
43	Mawṣil	77;0	34;30	Mosul, Iraq
44	Arbīl	77;20	35;0	Erbil, Iraq
Armīn (Armenia)				
45	Amid	73;40	38;0	Amid, Turkey
46	Malāzjird	75;0	38;45	Malzjird, Armenia
47	Anī	79;0	41;0	Ani, Armenia
Adarbayjān (Azerbaijan)				
48	Urmiya	79;45	37;0	Urmiya, Iran
49	Marand	80;45	37;50	Marand, Iran
50	Marāgha	82;0	37;20	Maragha, Iran
51	Tabrīz	82;0	38;0	Tabriz, Iran
52	Ardabīl	82;30	38;0	Ardabil, Iran
Irāq[387]				
53	Mūqān	83;0	38;0	
54	Bardaᶜa	83;0	40;30	Barda, Azerbaijan
Karaj				
55	Tiflis Dār al-Mulk al-Khāzim	83;0	43;0	Tiflis, Georgia
Alān				

[387] Ulugh Beg has Iran here, so also A062; but the astrolabe has clearly Iraq.

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	Identification/ Modern Name
56	Alān	83;0	44;0	in Degestan, Russia
57	Salqān	83;30	39;50	
58	Balkūya[388]	84;30	39;30	Bakaway, Caspian coast
59	Shamākhī Qaṣba Shirwān	84;30	40;50	Shamakhi, Azerbaijan
	Second Circle			
Rūs (Russia)				
60	Bāb al-Abwāb	85;0	43;0	Debent, Dagestan, Russia
61	Kūsāna Madīnat Rūs	87;0	43;0	Kumana, Russia
Bulghār (The Bulghars)				
62	Saqīn	86;30	43;0	Saqsīn, medieval city in the Volga delta
63	Bulghār	90;0	49;30	The Bulghars
ᶜArāqayn (the two Iraqs)[389]				
64	Kūfa	79;30	31;30	ancient city in ruins, Iraq
65	Madā’in	72;0	33;10	Al-Mada’in, Iraq
66	Baghdād	82;0	33;24	Baghdad, Iraq
67	Wāsiṭ	81;30	32;20	Wasit, Iraq
68	Baṣra[390]	84;0	30;0	Basra, Iraq

388 Ulugh Beg has the heading Armenia once more here, in which are included Balkūyah, Shamākhī and Bāb al-Abwāb.

389 Ulugh Beg has just ᶜIrāq here.

390 Ulugh Beg has a new heading here ‘Baṣra’ under which he places Basra and Abadan.

	Place Name (*asmā’ al-buldān*)	**L (*al-ṭūl*)**	**φ (*al-ᶜarḍ*)**	**Identification/ Modern Name**
69	ᶜAbādān	84;30	31;0	Abadan, Iran
Khūzistān (a region of Iran)				
70	Jundīsābūr	84;5	31;15	Gundeshapur, Iran
71	Tastīr	84;30	31;30	Tustar, Iran
72	ᶜAskar Mukram	84;30	31;15	Asker Mukram, Iran
73	Ahwāz	85;0	31;0	Ahwaz, Iran
74	Rāmhurmūz	85;45	31;0	Ram Hormoz, Iran
75	Arjān[391]	86;30	30;30	Arrajan, Fars Province, Iran
76	Shāpūr[392]	86;55	30;0	Sabur, Iran
Fārs (Persia, a province of Iran)				
77	Kāzirūn	87;0	29;15	Kazerun, Iran
78	Nūbandjān	87;15	30;10	Nawbandgan, Iran
79	Fīrūzābād	87;30	28;10	Firouzabad, Iran
80	Sīrāf	88;0	29;55	Siraf, Iran
81	Shīrāz	88;0	29;36	Shiraz, Iran
82	Iṣṭakhr	88;30	35;0	Persepolis, Iran
ᶜIrāq[393]				
83	Yazd[394]	89;0	32;0	Yazd, Iran

391 Ulugh Beg includes it in Fars.

392 Ulugh Beg includes it in Fars.

393 Ulugh Beg has ‘Jabāl’ as the heading here.

394 This place should be included in Iran.

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	Identification/ Modern Name
84	S[h]ahrazūr	82;20	32;30	(Kurdistan, Iraq)
85	Qirmāsīn	83;0	34;30	Kirmanshah, Iran
86	Saharward	83;20	36;0	Shahrud, Iran
87	Nahāwand Māh al-Baṣra	83;15	34;20	Nahavand, Iran
88	Arzinkān	83;40	36;30	Erzincan, Turkey
89	Hamadān	83;0	35;10	Hamadan, Iran
90	Karaj	84;45	34;0	Karaj, Iran
91	Qazwīn	85;0	35;0	Qazvin, Iran
92	Iṣfahān	86;40	32;25	Isfahan, Iran
93	Kāshān	86;0	34;0	Kashan, Iran
94	Qumm	85;40	35;45	Qom, Iran
95	Rayy	86;20	35;0	Shahr Rey, Iran
Dīlmān[395]				
96	Alamūt	85;37	36;21	Alamut, Iran
97	Ṭāliqān	85;0	36;10	Taloqan, Afghanistan
Kīlān (Gilan province, Iran)				
98	Hūsum az Jīlān	85;10	34;0	
99	Dīma Qaṣba Damāwand	87;20	37;10	
Ṭabaristān				
100	Amul Qaṣba Ṭabaristān	88;20	36;15	Amol, Northern Iran

[395] Ulugh reads *Dīlān*.

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	Identification/ Modern Name
101	Astarābād	89;35	36;50	Gorgan, Iran
Jurjān[396]				
102	Abaskūn Qaṣba Jurjān	89;30	37;15	Port city on the Caspian Sea in the Middle Ages
103	Jurjān	90;0	36;50	
Qūmis (a city in northern Iran) [397]				
104	Samnān	88;0	36;0	Semnan, Iran
105	Dāmghān	88;55	36;20	Damghan, Iran
106	Basṭām	89;30	36;10	Bastam, Iran
	Third Circle			
Iqlīmhā Khurāsān (the region of Khurasan)				
107	Farāwa	90;0	39;0	
108	Sabzawār	91;30	36;5	Sabzewar, Iran
109	Nīshābūr	92;30	36;21	Nishapur, Iran
110	Ṭūs	92;30	37;0	Tus, Iran
111	Turshīz	92;0	35;0	Turshiz, Iran
112	Tabas Kīlakī	92;0	33;0	Tabas, Iran
113	Tūn	92;30	34;30	Ferdows, Iran
114	Qā’īn	93;20	33;40	Qaen, Iran
115	Ṭabas Masīnā	94;15	33;15	Tabas-e Masina, Iran
116	Zūzan	93;30	35;20	Zuzan, Eastern Iran

396 Ulugh Beg has ‘Kurkān’.

397 Ulugh Beg has ‘Qaws’.

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	Identification/ Modern Name
117	Harāt	94;20	34;30	Herat, Afghanistan
118	Sarakhs	94;30	37;0	Sarakhs, Iran
119	Marw ar-Rūd	97;0	36;30	Bala Murghab, Afghanistan
120	Fāryāb	99;0	35;30	Faryāb, Iran
121	Balkh	101;0	36;41	Balkh, Afghanistan
Khatlān[398]				
122	Andarāb	103;45	36;0	Andarab, Afghanistan
123	Badakhshān	104;24	37;10	Faizabad, Afghanistan
Khwārizm				
124	Bulūr[399]	108;0	37;0	??
125	Nūkarkānj	93;0	42;35	??
126	Kurkanj Dār al-Mulk Khwarizm	94;30	42;17	Gurganj, cap. Khwarizm
127	Hazār Asf	95;0	41;0	Hazar Asp, Iran
128	Kāt	95;0	41;36	ancient cap. Khwarizm
129	Darqān[400]	94;15	39;30	Darghan, near Hazar Asp, Iran
Mā Warā’ al-Nahr (Transoxonia)				
130	Bukhārā	97;30	39;50	Bukhara, Uzbekistan
131	Samarqand	99;16	39;37	Samarqand, Uzbekistan

398 Ulugh Beg reads Khīlān.

399 Engraved on the astrolabe as Buslūz.

400 Ulugh Beg includes it in Transoxonia.

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	Identification/ Modern Name
132	Nasaf	98;0	39;0	
133	Kish	99;30	39;30	Kish, Iran
134	Isfījāb az Shāsh	99;50	43;36	Sayram, South Kazakhstan
135	Usrūshana	100;0	40;0	Istaravshan, Tajikistan
136	Khujand	100;35	41;55	Sughd, Tajikistan
137	Binkat Qaṣba Shāsh	101;0	43;0	Binkath, main city Shash
138	Tūnkat Qaṣba Aylān	101;0	43;25	Tunkath, main city in Ilaq
139	Akhshikāt Qaṣba Farghāna	101;20	42;25	In Ferghana, Uzbekistan
140	Ūzkand	102;50	44;0	
141	Ūsh	102;20	43;20	
	Fourth Circle			
Tatimma Iqlīmhā Turk (continuation of the region of Turkistan)[401]				
142	Kāshghar[402]	106;30	44;0	Kashgar, China
143	Chāj vahū Shāsh[403]	109;0	42;30	??, in Shash
144	Khutan	107;0	42;0	Khotan, China
145	Almāligh	102;30	44;0	Turkish Central Asia
146	Qabāligh	108;0	44;0	Turkish Central Asia

401 It is not a ‘continuation,’ but a new heading!

402 Ulugh Beg includes it in Transoxonia.

403 Ulugh Beg includes it in Transoxonia.

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	Identification/ Modern Name
147	Awsh Klūrān	110;0	46;0	Turkish Central Asia
148	Pīsh Bāligh	111;0	45;50	Pochongtse, Uighur (in ruins)
149	Qarāqūrūm	112;0	46;0	Karakorum, Mangolia
150	Khān Bāligh	124;0	46;0	Beijing, China
Kirmān (Kerman Province, Iran)				
151	Shīrjān	90;20	29;30	Sirjan, Iran
152	Hurmūz	92;0	25;0	Hormuz, Iran
153	Bardsīr	92;30	29;50	Birdsir, Iran
154	Jīruft	93;0	27;30	Jiroft, Iran
155	Bam	94;0	28;30	Bam, Iran
156	Narmāsīr	94;20	29;0	Narmasir, Iran
157	Khabīs	93;0	31;0	Khabis, Iran
Zābalistān				
158	Zaranj Madīna Sijistān[404]	90;0	32;30	Zaranj, Afghanistan
159	Bust	100;0	33;0	Bost, Afghanistan
160	Takinābād	101;55	33;20	Takinabad, Afghanistan
161	Maymand	101;55	33;20	Maymand, Afghanistan
162	Ghazna Qaṣba Zābalistān	104;20	33;35	Ghazna, Afghanistan

[404] Ulugh Beg places it under the heading Zaranj

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	Identification/ Modern Name
163	Banjahīr az Kābulistān[405]	104;40	35;0	Banjahir, Afghanistan
164	Ribāṭ Amīr	105;0	34;0	
Makrān				
165	Basīr Qaṣba Makrān	98;0	26;15	
166	Kīj az Makrān	99;0	28;0	
167	Jālq az Makrān	99;0	30;0	Jalq, Pakistan
Sind				
168	Daybul wa Hūnah[406]	102;30	25;10	Debal, near Karachi, Pakistan
169	Manṣūra Qaṣba Sind	105;0	27;40	Brahmanabad, Pakistan
170	Tāna az Sāḥil Bahr Hind	102;0	39;20[407]	‘Tanah on the coast of The Sea of India’, Thane, Maharashtra
Hind[408]				
171	Nahlāwāra	102;30	22;0	Patan, Gujarat
172	Sawmnāt	106;0	17;0	Somnath, Gujarat

405 Ulugh Beg places this and the next locality under the heading ‘Kābūlistān’; the astrolabe does not have this reading.

406 Ulugh Beg includes it in Makrān.

407 The latitude is wrong; it should be 19;20° as given by Ulugh Beg. Astrolabe A093 gives the longitude and latitude correctly as given by Ulugh Beg and adds the maximum duration of daylight as 13;12 hours, which is correct for the latitude of 19;20°. However, both the astrolabes place it wrongly in the region of Makran, instead of in Hind.

408 Ulugh Beg lists just nine places in Hind (Tāna, Nahlāwāra, Sawmnāt, Multān, Qandahār, Lahāwar, Qannawj dār al-Mulk Hind, Banāras and Sarandīb); the rest here are derived from some other source.

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	Identification/ Modern Name
	Fifth Circle			
Tatimma Iqlīmhā Hind (continuation of the region of Hind)				
173	Mūltān	107;35	29;40	Multan, Pakistan
174	Qandahār	107;40	33;0	Qandahar, Afghanistan
175	Lahāwar	109;20	31;50	Lahore, Pakistan
176	Qannawj Dār Mulk Hind[409]	102;50	26;35	Kannauj, UP, India
177	Bānārasī	117;20	26;55	Varanasi, UP, India
178	Sarandīp	130;0	10;0	Sri Lanka
179	Kashmīr	108;0	35;0	Srinagar, India
180	Akbarābād	114;0	26;43	Agra, India
181	Haḍrat Shāhjahānābād	113;0	28;39	Delhi, India
Tatimma Iqlīmhā Hind (continuation of the regions of Hind)				
182	Ghāzīpūr	119;40	26;40	Ghazipur, UP, India
183	Munkīr	121;45	26;40	Munger, Bihar, India
184	Ilāhābād	115;34	26;50	Allahabad, UP, India
185	Sūrat	108;50	20;15	Surat, Gujarat, India
186	Bahrā’ich	117;30	28;0	Bahraich, UP, India
187	Kūrakpūr	119;15	27;20	Gorakhpur, UP, India
188	Māndū	114;13	22;13	Mandu, MP, India
189	Kawāliyār	115;0	26;29	Gwalior, MP, India

[409] Ulugh Beg refers to Kannauj as the capital city of India.

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	Identification/ Modern Name
190	Kalkanda	114;39	18;4	Golconda = Hyderabad, India
191	Dhāka Bankālā	130;0	27;0	Dhaka, Bangladesh
192	Sanārkām	131;0	26;0	Sonār Gām, Bangladesh
193	Qakaj	-----	26;0	Overwritten illegible
194	Kūl	114;19	28;6	Aligarh, UP, India
195	Burhānpūr	109;0	20;31	Burhanpur, MP, India
	Sixth Circle			
Tatimma Iqlīmhā Hind (continuation of the region of Hind)				
196	Bahrūj	111;5	21;20	Bharuch, Gujarat, India
197	Sirhind	111;33	30;30	Sirhind, Panjab, India
198	Patna	120;45	26;40	Patna, Bihar, India
199	Rahtās	119;45	26;30	Rohtas, Bihar, India
200	Sulṭānkūt	104;0	33;0	Sultankot, UP, India
201	Sanbhal	115;0	28;4	Sambhal, UP, India
202	Kara	117;6	26;36	Kara, UP, India
203	Khanbāyat	109;4	22;20	Cambay, Gujarat, India
204	Jidda	76;0	21;0	Jeddah, Saudi Arabia
205	Bījāpūr	105;30	17;20	Bijapur, India
206	Dawlatābād	111;0	20;30	Daulatabad, India
207	Kūpāmā’u	116;33	26;45	Gopamau, India
208	Jawnpūr	119;6	26;36	Jaunpur, UP, India
209	Mānikpūr	118;10	26;49	Manikpur, UP, India

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	Identification/ Modern Name
210	Aḥmadnakar	107;0	19;0	Ahmednagar, Maharashtra, India

Figure A072.7 – Back of the astrolabe (photo by S. R. Sarma)

BACK

The rim of the two upper quadrants bears altitude scales which are divided in 0;20°, 1° and 5° and labelled in 5s as 5—90; 90—5 in *abjad* letters. In addition, in the upper left quadrant, the groups of 5° are numbered also in the reverse direction, i.e., from the south point to the east point, in common Arabic/Persian numerals. This numbering in both directions is useful when measurements are done with the sine quadrant inscribed in the upper left.

In the upper left is the trigonometric quadrant with 60 horizontal and 60 vertical parallels, with every fifth line highlighted with dots. These parallel lines are numbered along the two radii in groups of five thus: 5, 10, … 60.

In the upper right is the solar quadrant with thirty equally spaced arcs of declination, where also every fifth line (marking the boundary of a zodiac sign) is dotted. The names of the related signs are engraved along the two radii, along with the numerical values of their subdivisions as 6, 12, 18, 24, 30, separately for each sign.

In this quadrant are plotted three sigmoid curves of the solar meridian altitude at the three latitudes of 27°, 29°, 32°, representing the three Mughal imperial capitals Agra, Delhi and Lahore. These curves are accompanied by labels reading *khaṭṭ niṣf al-nahār bi-*^{c}*arḍ* 27; … 29, … 32.

In the lower half are engraved the shadow squares, on the left for a base of 7 and on the right for a base of 12 and 60. The vertical and horizontal scales on the left are divided into 7 parts and numbered accordingly. The vertical and horizontal scales on the right are divided into 12 parts and numbered accordingly; here each is further subdivided into 5 units.

Vertical scale on the left	*ẓill sullam aqdām ma*^{c}*kūs*
Horizontal scale on the left	*ẓill sullam aqdām mustawī*
Horizontal scale on the right	*ẓill sullam aṣābi*^{c} *wa sittaynī mustawī*
Vertical scale on the right	*ẓill sullam aṣābi*^{c} *wa sittaynī ma*^{c}*kūs*

Inside the shadow squares, there is a table with the heading *zadwal sā*^{c}*āt ṭulū*^{c} *burūj bi-*^{c}*arḍ ba*^{c}*ḍī az bilād mulk al-Hind* (table of the times of rising of signs in the latitudes

of some of the localities belonging to the country of India).[410] This table provides the rising times of the signs at each degree of latitude from 20° to 39° which roughly corresponds to the extent of the Mughal empire from Burhanpur at 20° in the south up to northern Afghanistan at about 35° in the north.

Table A072-4 Rising Times of the Signs

Signs → **Latitudes**	**Aries Pisces** (h;m)	**Taurus Aquarius** (h;m)	**Gemini Capricorn** (h;m)	**Cancer Sagittarius** (h;m)	**Leo Scorpio** (h;m)	**Virgo Libra** (h;m)
20°	1;34	1;46	2;3	2;14	2;14	2;9
21°	1;34	1;45	2;3	2;15	2;14	2;10
22°	1;33	1;44	2;3	2;10	2;16	2;10
23°	1;32	1;44	2;2	2;10	2;16	2;9
24°	1;31	1;43	2;2	2;16	2;16	2;12
25°	1;30	1;42	2;2	2;16	2;17	2;13
26°	1;29	1;41	2;1	2;16	2;18	2;14
27°	1;28	1;40	2;1	2;17	2;19	2;15
28°	1;27	1;39	2;0	2;17	2;20	2;16
29°	1;26	1;38	2;0	2;17	2;21	2;18
30°	1;25	1;38	2;0	2;18	2;22	2;19
31°	1;25	1;37	1;39	2;18	2;23	2;20
32°	1;22	1;36	1;18	2;19	2;24	2;21
33°	1;21	1;35	1;18	2;19	2;25	2;22
34°	1;20	1;34	1;18	2;20	2;26	2;23

410 This table occurs only in three astrolabes by Ḍiyā’ al-Dīn, here and in A092 (from 20° to 40°) and in A093 (from 21° to 40°).

35°	1;19	1;33	1;18	2;20	2;27	2;24
36°	1;18	1;32	1;17	2;20	2;28	2;26
37°	1;16	1;31	1;17	2;21	2;29	2;27
38°	1;16	1;29	1;17	2;21	2;30	2;28
39°	1;14	1;28	1;16	2;22	2;31	2;30

The shadow squares are enclosed in 10 concentric semi-circular rows. The first two rows are engraved with the cotangent scales in digits and in feet and their subdivisions. In the next two rows are engraved the names of the 12 zodiac signs and the names and serial numbers (in common Arabic/Persian numerals) of the 28 lunar mansions respectively.

A table of limits occupies the rows 5 and 6. In row 5 are engraved the full names of the five planetary lords of each sign. In the next row are given the numerical limits of the five terms twice; the individual limits in *abjad* and the cumulative limits in common Arabic/Persian numerals. For example, the data about the third sign *al-Jawzā’* (Gemini) is as follows. The cumulative limits are shown in *italics.*

ᶜAuṭārad (Mercury)	*Mushtarī* (Jupiter)	*Zuhrah* (Venus)	*Mirrīkh* (Mars)	*Zuḥal* (Saturn)
6 *6*	6 *12*	5 *17*	7 *24*	6 *30*

The rows 7 and 8 contain the table of the decans and their planetary regents. The last two rows give once again the decans, but with different planetary regents than the conventional ones. For example, the table related to the sign *al-Jawzā’* is as follows:

Mushtarī (Jupiter)	*Mirrīkh* (Mars)	*Shams* (Sun)
10°	20°	30°
ᶜAuṭārad (Mercury)	*Zuhrah* (Venus)	*Zuḥal* (Saturn)
10°	20°	30°

ALIDADE

The straight bar alidade has ornate ends and a matching ornate centre-piece. On the left side is engraved a zodiac scale to match the upper right quadrant on the back, with the names of the signs engraved in full. On the right hand side is a sexagesimal scale labelled in 5s from 5 to 60. In a lower register there is also a scale of seasonal hours to measure time when the alidade is used as a sundial with the sighting plate on the right as the gnomon. The wedge is nicely formed as a horse’s head.

INSCRIPTION

Figure A072.8 – Signature of the astrolabe maker (photo by S. R. Sarma)

Directly below the horizontal diameter is engraved the astrolabe maker’s signature in two lines and two segments, one on the right and the other on the left:

ᶜamal aqall al-ᶜibād ḍiyā’ al-dīn muḥammad ibn
shaykh qā’im muḥammad ibn mullā ᶜīsā ibn shaykh allāhdād
humāyūnī asṭurlābī lāhūrī
fī sanah 1067 hijrī julūs mubārak shah jahān 31

‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn Muḥammad, son of Shaykh Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1067 Hijrī, in the blessed regnal year 31 of Shāh Jahān.’

PROVENANCE

It was acquired by Sawai Jai Singh in the first quarter of the eighteenth century along with some other masterpieces of the Lahore astrolabes. In about 1917 when G. R. Kaye was preparing his book on Jai Singh’s observatories, the astrolabe was with the Jaipur Museum; later, at some uncertain date, it was transferred to the Jaipur Observatory.

BIBLIOGRAPHY

Kaye 1917, p. 16 ff, where this astrolabe is designated as ‘Jaipur B (Astrolabe dated the 31st year of the reign of Shāh Jahān and A. H. 1067 (= A.D. 1657).’ Fig. 6 (front), Fig. 8 (back) and Fig. 13 (gazetteer).

Gunther 1932, no. 75, p. 206, figs. 104 (back), 105 (*kursī*) and 106 (front).

A073☉ ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1068 AH (AD 1657-58)

Diameter 171 mm

Paris, PC.

Répertoire 16, 18[411]

Figure A073.1 – Front of the astrolabe (photo by S. R. Sarma)

[411] The Répertoire lists this astrolabe twice; the description is the same in both cases, but the location varies; under 16, ‘coll[ection] particulière, under 18, ‘coll. Jean Soustiel’.

Components

Body with *kursī* (d. 171, h. 218, t. 8), shackle and ring, rete (d. 158) for 45 stars, 5 plates, alidade, pin, washer and horse.

Front

Ring has an octagonal cross-section, the shackle is of trifoliate shape, the *kursī* pierced and engraved on the surface. Limb divided in 1° and 5° and labelled from 5 to 360.

Rete

The rings of Capricorn and Ecliptic are held together by the east-west equinoctial bar, which has counter changes at its two intersections with the ecliptic ring, and by the solstitial bar which is partly represented. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names; each sign divided into groups of 6° and numbered as 6, 12, …30; these units are further subdivided into 1°.

There are 18 star pointers outside the ecliptic and 27 inside. These are joined by an elegant floral tracery consisting of branches, leaves and flowers with six petals each. A small *zawraqī* horizon for latitude 32° is placed inside the ecliptic ring. There is a handle at the west point and a triangular Capricorn index at the south point.

Figure A073.2 – Rete of the astrolabe (photo by S. R. Sarma)

PLATES

There are 5 plates.

Table A073-1 Plates

	φ	Longest day
1a	18°	13;12 hours
1b	22°	13;22 hours
2a	25°	13;35 hours
2b	27°	13;43 hours
3a	29°	13;52 hours
3b	32°	14;8 hours

	φ	Longest day
4a	35°	14;25 hours
4b	Special plate to be used with *zawraqī* horizon	
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

On plates 1, 2, 3 and 4a, altitude circles are drawn for each 1°, with every fifth dotted. Azimuth arcs are traced for each 6° below the oblique horizon, each fifth of these (30°) is dotted and extended above the horizon. In the lower half, there are plain lines for seasonal hours and dotted lines for equal hours which are drawn from the western horizon. Plate 4b is designed to be used along with the *zawraqī* horizon on the rete; it has two notches at the south and north points

Geographical Gazetteer

The geographical gazetteer on the inner side of the mater provides the names, longitudes and latitudes of 116 localities arranged according to climates. It is almost the same as the gazetteers in A082 for 128 localities and A088 for 124 localities, but for the addition and deletion of a few localities.

Figure A073.3 – Geographical gazetteer (photo by S. R. Sarma)

BACK

The rim of the two upper quadrants is divided in 1° and 5° and labelled twice; once in *abjad* notation 5—90; 90—5; and again with common Arabic/Persian numerals in the reverse direction 90—5; 5—90.

The upper left quadrant has 60 vertical and 60 horizontal parallels with every fifth dotted. These are numbered in 5s along the vertical and horizontal diameters from 5 to 60, starting from the centre and reaching up to the arc.

The upper right quadrant is divided by 30 declination arcs, the intervening spaces representing 6° of solar longitude. The corresponding names of the zodiac signs and the numerical values of their subdivisions (6, 12, …30 for each sign) are written along the

two radii. On these arcs are drawn three curves to show the meridian altitudes of the sun at latitudes 27°, 29° and 32°, with the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27, khaṭṭ niṣf al-nahār bi-ᶜarḍ 29, khaṭṭ niṣf al-nahār bi-ᶜarḍ 32.*

in

Figure A073.4 – Back of the astrolabe (photo by S. R. Sarma)

In the lower half are engraved shadow squares, on the left for a base of 7 and on the right for a base of 12, with the usual divisions and labels. Inside the shadow squares are two rectangular tables, on the left the table of the excess of revolution (*faḍl al-dawr*) and on the right the table of triplicities.

The shadow squares are enclosed by 8 semi-circular rows.

Rows1-2, counted from outside, carry scales of cotangents and their subdivisions;
rows 3-4 the names of the 12 signs and the names of the 28 lunar mansions;
rows 5-6 the limits of signs (*ḥudūd*); and
rows 7-8 the decans and their regents (*wujūh*).

INSCRIPTION

Immediately below the horizontal diameter is the astrolabe maker’s signature:

ᶜamal aqall al-ᶜibād ḍiyā’ al-dīn muḥammad
ibn qā’im muḥammad ibn mullā ᶜīsā
ibn shaykh allāhdād asṭurlābī humāyūnī
lāhūrī fī sanah 1068 hijrī

‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1068 Hijrī.’

PROVENANCE

The astrolabe was on loan to the Institut de Monde Arabe at Paris where I saw it in 1994 summer; I understand that it was subsequently returned to the private collector who owns it.

A074⊙ ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1069 AH (AD 1658-59)

Diameter 175 mm

Oxford, Museum of the History of Science (#53637)

CCA 77=1002; Répertoire 19

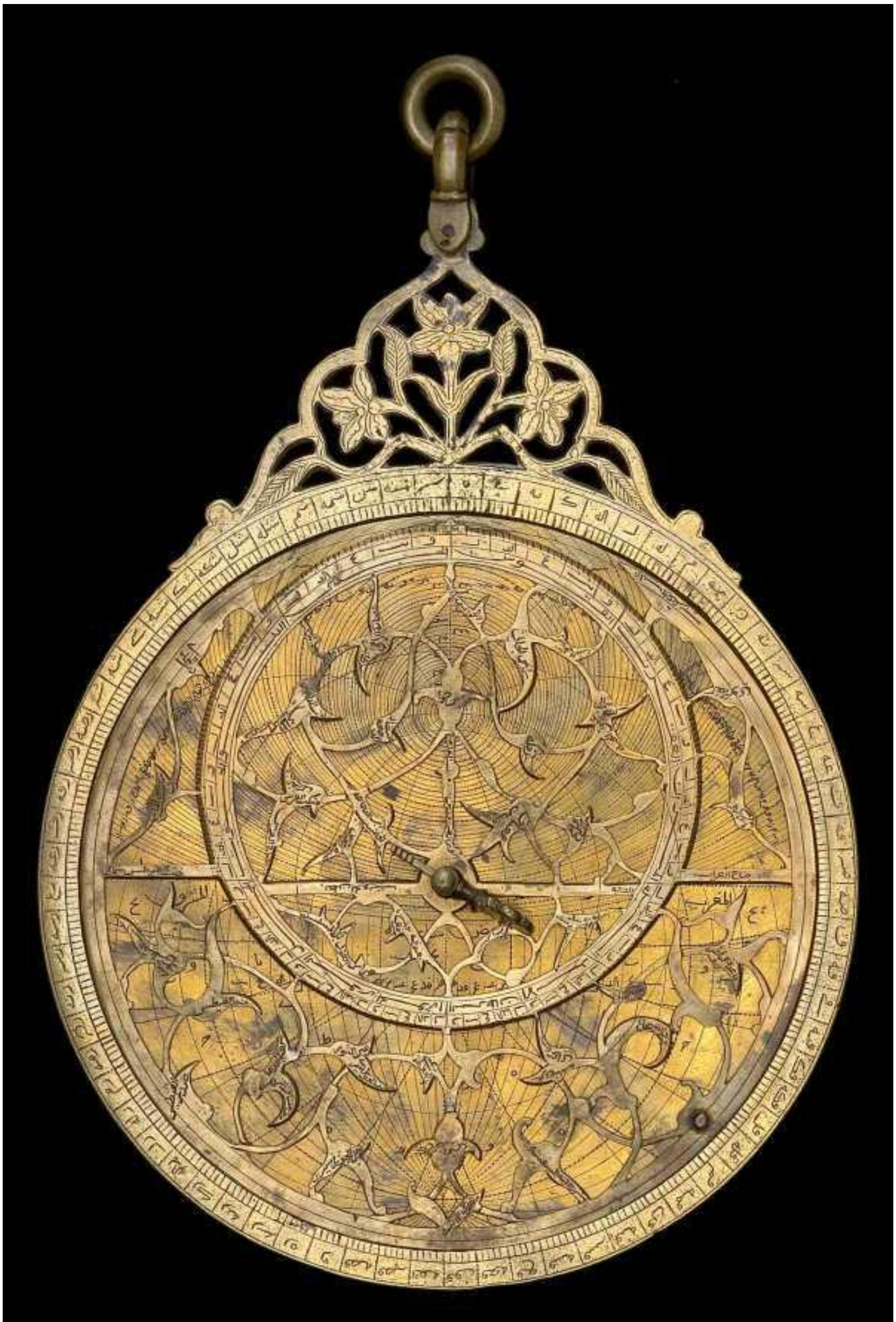

Figure A074.1 – Front of the Astrolabe (© Museum of the History of Science, Oxford)

COMPONENTS

Body with *kursī* (d. 176, h. 233, t. 6), shackle and ring, rete (d. 158) for 57 stars, 5 plates (d. 158), alidade (162 x 15), pin and horse. The horse seems to be a replacement.

FRONT

The ring has an octagonal cross-section; the shackle is trifoliate. The profiles of the *kursī* are formed by ogees rising from the body of the astrolabe, followed by a lobe and one more ogee, and finally topped by a trifoliate finial. These profiles form the frame inside which is arranged a bouquet of three large flowers and six leaves. The petals of the flowers and the leaves are marked by engravings on the surface. The limb is divided in 1° and 5° and labelled from 5 to 360.

RETE

In the rete, the two rings of the Tropic of Capricorn and of the ecliptic are held together by the equinoctial bar which has counter changes at its two intersections with the ecliptic. The solstitial bar is also partly represented. The ecliptic ring is divided into the 12 signs of zodiac and labelled with their names. Each sign is subdivided into groups of 6° and numbered accordingly. On the sloping edge, an effort was made to divide it into 1°, but the divisions are not uniform.

There are 57 named star pointers which are joined by a floral tracery. At two points the tracery is broken and welded together.

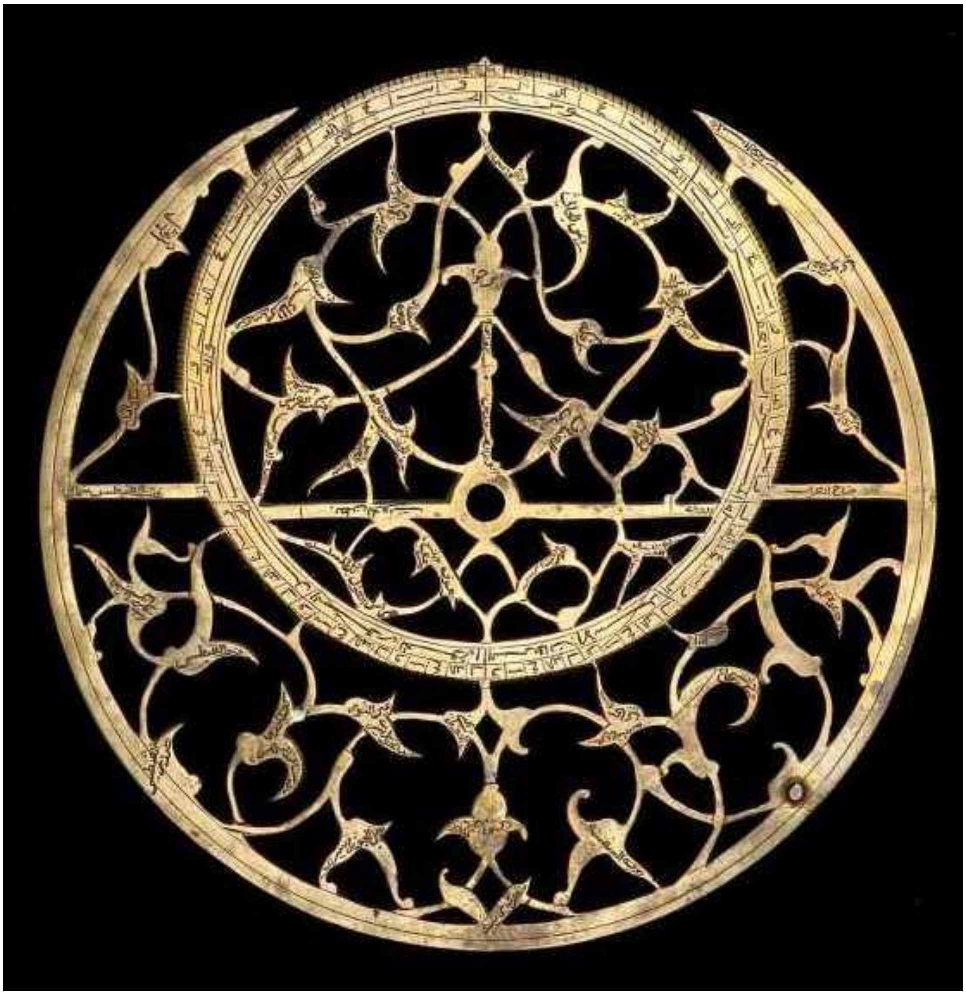

Figure A074.2 – Rete of the astrolabe (© Museum of the History of Science, Oxford)

Table A074-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus Janūbī*	β Ceti
2	*Batn al-Ḥūt*	β Andromedae
3	*Rijl al-Musalsala*	γ Andromedae
4	*Fam al-Qayṭus*	γ Ceti
5	*Ṣadr al-Qayṭus*	π Ceti
6	*Rās al-Ghūl*	β Persei
7	*Kaff al-Jadhmā*	α Ceti
8	*Mirfaq al-Thurayyā*	α Persei
9	*Tālī Masāfat al-Nahr*	γ Eridani

	Star Name	Identification
10	*ᶜAyn al-Thawr*	α Tauri
11	*Al-ᶜAyyūq*	α Aurigae
12	*Rijl al-Jawzā’ Yusrā*	β Orionis
13	*Yad al-Jawzā’ Yusrā*	γ Orionis
14	*Yad al-Jawzā’ Yumnā*	α Orionis
15	*Rijl al-Jawzā’ Yumnā*	κ Orionis
16	*Shiᶜrā Yamānī*	α Canis Majoris
17	*Shiᶜrā Shāmī*	α Canis Minoris
18	*Tarfat al-Safīna*	ρ Puppis
19	?	
20	?	
21	*Fard al-Shujāᶜ*	α Hydrae
22	*Qalb al-Asad*	α Leonis
23	*Ẓahr Dub Akbar*	α Ursae Majoris
24	*Qāᶜidat al-Bāṭiya*	α Crateris
25	*Ẓahr al-Asad*	δ Leonis
26	*Rās al-Asad*	μ Leonis
27	*Al-Ṣarfa*	β Leonis
28	*Al-ᶜAnāq*	ζ Ursae Majoris
29	*Janāḥ al-Ghurāb*	γ Corvi
30	*Simāk Aᶜzal*	α Virginis
31	*Simāk al-Rāmiḥ*	α Bootis
32	*Kiffa Janūbī*	α Librae
33	*Kiffa Shamālī*	β Librae

	Star Name	Identification
34	*Nayyir Fakka*	α Coronae Borealis
35	*ᶜUnuq al-Ḥayya*	α Serpentis
36	?	
37	*Qalb al-ᶜAqrab*	α Scorpii
38	*Rās al-Jāthī*	α Herculis
39	*Rās Ḥawwā’*	α Ophiuchi
40	*ᶜAyn al-Tinnīn*	γ Draconis
41	*Yad al-Ḥawwā’ al-Yumnā al-Muqaddam*	δ Ophiuchi
42	*Anwar al-Farqadayn*	β Ursae Minoris
43	*Nasr al-Wāqiᶜ*	α Lyrae
44	*ᶜIṣābat al-Rāmi*	ρ Sagittarii
45	*Minqār al-Dajāja*	β Cygni
46	*Nasr Ṭā’ir*	α Aquilae
47	*Dhanab al-Dulfīn*	ε Delphini
48	?	
49	*Dhanab al-Dajāja*	α Cygni
50	*Fam al-Faras*	ε Pegasi
51	*Dhanab al-Jadī*	δ Capricorni
52	*Ṣāq Sākib al-Mā’ J[anūbī]*	δ Aquarii
53	*Dhanab al-Qayṭus Shamālī*	ι Ceti
54	*Mankib al-Faras*	β Pegasi
55	*Kaff al-Khaḍīb*	β Cassiopeiae
56	*Janāḥ al-Faras*	γ Pegasi
57	*Surrat al-Faras*	δ Pegasi

PLATES

There are five plates with the following specifications

Table A074-2 Plates

	φ	Longest day
1b	22°	13;22 hours
2a	25°	13;35 hours
2b	27°	13;43 hours
3a	29°	13;52 hours
3b	32°	14;8 hours
4a	35°	14;24 hours
4b	38°	14;44 hours
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

On plates 1 to 4, altitude circles are drawn for each 1° and every sixth is dotted. On plate 1a and 1b, these circles are numbered twice in two rows, one below the other, both on the left and right. On other plates, the circles are numbered in the usual manner both on the left and on the right. Azimuth arcs are drawn for every 6° below the horizon; every fifth arc (30°) is drawn above and below the horizon and dotted below the horizon.

Lines for seasonal hours are drawn on all plates. Lines for equal hours are drawn from the western and eastern horizons on plates 1a, 1b and 2b; on the rest from the western horizon.

On the tablet of ecliptic coordinates (5a), the circles of celestial latitudes are drawn for every 2° and the arcs of the celestial longitudes for every 6°. The names of the zodiac signs and the numerical values of their subdivisions are engraved along the ecliptic circle. Above the north point is the label *ṣafīḥat mīzān al-ᶜankabūt.*

The reverse side of this plate (5b) is engraved with the tablet of horizons and carries the label *ṣafīḥa āfāqī.* Here four sets of half horizons are engraved for every degree of latitude from 3 to 90°.

3	7	11	…	83	87	90
4	8	12	…	84	88	90
5	9	13	…	85	89	90
6	10	14	…	82	86	90

These are accompanied by declination scales, numbered as 6, 12, 18, 23;30 and labelled *taqsīm mayl kullī janūbī* (division or scale of the maximum declination south) or *taqsīm mayl kullī shamālī* (division or scale of the maximum declination north).

This is one of the rare horizon plates, for it has notches at all the four cardinal points so that all the four sets of horizons can be made use of.

Figure A074.3 – Geographical gazetteer (© Museum of the History of Science, Oxford)

GEOGRAPHICAL GAZETTEER

The gazetteer is engraved in three circles to provide the names, longitudes and latitudes of 89 places, arranged according to climates. The entries are engraved in a zig-zag manner.

Table A074-3 Geographical Gazetteer

	Place Names *asmā’ al-buldān*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*	
	Outer Circle			
[-I] *az khaṭṭ istiwā’ tā iqlīm awwal* (from the equator up to the first climate)				
1	Ṣāhil Baḥr Awqiyānūs	11;0	0;0	
2	Jazīra Qanabala	21;0	3;0	Madagascar
3	Jamkūt	177;0	5;0	
4	Thala	180;0	5;0	
5	Kūkū	54;10	10;0	
6	ᶜAdan	76;0	11;0	
[I] *al-iqlīm al-awwal* (the first climate)				
7	Jabal	75;0	13;30	
8	Damār	77;15	13;30	
9	Bajja al-Barbar	10;0	14;0	
10	Dabīl	74;20	14;10	
11	Sanᶜā‘ Dar al-Mulk Yaman	77;30	14;30	
12	Jind	75;30	14;30	
13	Sawmnāt	107.0	14;30	
14	Zatūn	114;0	17;15	
15	Bījāpūr	105;30	17;20	

	Place Names *asmā’ al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*
16	Burhānpūr	103;0	20;30
17	Dawlatābād	111;0	20;30
[II] *al-iqlīm dūyam* (the second climate)			
18	Jadda	76;0	21;0
19	Makka Muᶜaẓẓam	77;10	21;40
20	Madīnat Musharrafa	75;20	25;0
21	Tā’if	77;30	21;20
22	Kanbāyat	109;20	22;20
23	Khaybar	75;20	24;20
24	Hurmūz	92;0	25;0
25	Ajmīr Haḍrat Khwājā[412]	111;5	26;0
26	Kawāliyār	114;0	26;29
27	Qannawj	115;50	26;35
28	Jawnpūr	119;6	26;36
29	Akbarābād Dar al-Khilāfat	114;0	26;43
30	Kara wa Mānikpūr	118;10	26;49
[III] *al-iqlīm siwum* (the third climate)			
31	Kūlkanda	114;19	18;4

412 Haḍrat Khwājā is a refrence to the Sufi saint Khwājā Moinuddin Chishti whose mauloseum is in Ajmer.

	Place Names *asmā’ al-buldān*	**L** *al-ṭūl*	**φ** *al-ʿarḍ*
32	Kūl Jalālī	114;19	28;4
33	Haḍrat Shāhjahānābād	113;35	28;39
34	Pānīpatah	113;20	28;20
35	Shīrāz	88;0	29;36
36	Multān	107;35	29;40
37	Hānsī	112;25	29;45
38	Baṣra	84;0	30;0
39	Kirmān	91;30	30;5
	Middle Circle		
[III] *tatimma al-iqlīm siwum* (continuation of the third climate)			
40	Tānīsar	112;33	30;10
41	Iskandariyya	61;54	30;18
42	Miṣr	63;20	30;20
43	Sunām	112;25	30;30
44	Bayt al-Maqdis	66;30	31;50
45	Lāhūr Dār al-Salṭanat	109;20	31;50
46	Yazd	89;0	32;0
47	Iṣfahān	82;40	32;25
48	Qandahār	82;40	33;0
49	Madā’in	72;0	33;0
50	Dimashq	70;0	33;15
51	Baghdād	82;0	33;25

	Place Names *asmā’ al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*
[IV] *al-iqlīm chahāram* (the fourth climate)			
52	Kāshān	86;0	34;0
53	Mawṣil	74;0	34;30
54	Kābul	104;40	34;30
55	Kashmīr	108;0	35;0
56	Hamadān	83;0	35;10
57	Ḥalab	72;10	35;50
58	Mashhad Maqdis	92;30	36;0
59	Bustām	89;30	36;10
60	Balkh	101;0	36;41
61	Tāliqān	85;45	36;10
62	Badakhshān	84;24	37;10
[V] *al-iqlīm panjum* (the fifth climate)			
63	Samarqand	99;16	39;37
64	Bukhārā	97;30	39;50
65	Tubbat	110;0	40;0
66	Burdaᶜa	83;0	40;30
67	Shamākhī	84;30	40;50
68	Khujand	85;35	41;55
69	Khutan	82;0	42;0
70	Farghāna	82;0	42;20
	Inner Circle		
[VI] *al-iqlīm shashum* (the sixth climate)			

	Place Names *asmā’ al-buldān*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*	
71	Kāshghar	106;30	44;0	
72	Bandaqiya	92;0	44;0	
73	Shalkh	85;30	44;0	
74	Ṭarāz	99;50	44;31	
75	Bīsh Bāligh	112;0	44;50	
76	Qarāqūrūm	115;0	46;0	
77	Khān Bāligh	124;0	46;0	
78	Harqala	67;20	46;30	
[VII] *al-iqlīm haftum* (the seventh climate)				
79	Araq	105;0	48;0	
80	Bulghār	90;0	49;30	
81	Aqchā Kirmān	62;0	50;0	
82	Qirqir	65;15	50;0	
83	Jazā’ir	Rūdjard	68;50	62;0
[VII+] *al-iqlīm khāriz* (beyond the [seventh] climate)[413]				
84	Dhāka Bankālā	130;0	27;0	
85	Patnah	120;45	26;40	
86	Ghāzīpūr	119;40	26;40	
87	Munkīr	121;45	26;40	Mungher
88	Ilāhābād	115;34	26;50	
89	Sūrat	110;50	20;15	

[413] Although the superscript refers to places north of the seventh climate, the six places listed here are from the third climate, placed here as addenda.

BACK

The rim of the two upper quadrants carries altitude scales which are divided in 1° and 5° and labelled as 5—90; 90—5. The upper left quadrant has 60 horizontal and 60 vertical parallels, each fifth dotted; the lines are numbered along the two radii as 5, 10, 15 … 60.

The upper right quadrant has 30 declination arcs for each 6° solar longitude; the names of the signs and the numerical values of their subdivisions (6, 12, 18, 24, 30) are written along the two radii.

In the lower half are engraved shadow squares, on the left for a base of 7 feet and on the right for a base of 12 digits. The vertical and horizontal scales on the left are divided into 7 parts and numbered accordingly. The vertical and horizontal scales on the right are divided into 12 parts and numbered accordingly; these parts are further subdivided into 5 units each. The four scales are accompanied by the following labels:

Vertical scale on the left :	*ẓill sullam aqdām m*ᶜ*akūs*
Horizontal scale on the left:	*ẓill sullam aqdām mustawī*
Horizontal scale on the right:	*ẓill sullam aṣābi*ᶜ *wa sattaynī mustawī*
Vertical scale on the right:	*ẓill sullam aṣābi*ᶜ *wa sattaynī m*ᶜ*akūs*

Inside the shadow squares are engraved two rectangular tables. The table to the left of the vertical diameter is entitled *jadwal faḍl al-dawr* (excess of revolution).

The table on the right carries the heading *jadwal arbāb muthallathāt laylī was nahārī* and displays triplicities in four sub-tables, each devoted to an element: *nārī wa tarābī* (fiery and earthy) and *hawā’ī wa māhī* (airy and watery).

The rim of the lower half carries cotangent scales, on the left in feet and on the right in digits. The next two rows contain the names of the 12 zodiac signs and the names of the 28 lunar mansions. The latter are also numbered serially in the standard Arabic/Persian numerals. The next two rows display the limits of the signs, while the last two rows show the decans and their regents.

Figure A074.4 – Back of the astrolabe (© Museum of the History of Science, Oxford)

ALIDADE

The alidade is well crafted with ornate ends and an ornate centre piece. The right arm carries a sexagesimal scale numbered in 5s from the centre to the tip from 5 to 60. On the lower half of the right arm is a scale of seasonal hours. The left arm carries a declination scale corresponding to the arcs of the signs of the zodiac together with the names of signs arranged in pairs as in the upper right quadrant.

INSCRIPTION

> *ᶜamal aqall al-ᶜibād ḍiyā’ al-dīn muḥammad ibn qā’im muḥammad ibn mullā ᶜīsā ibn shaykh allāhdād asṭurlābī humāyūnī lāhūrī fī sanah 1069 hijrī gh-s-ṭ*
>
> ‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1069 Hijrī, [in abjad notation] 1000+60+9.’

The year corresponds to AD 1658-59.

PROVENANCE

Gift of Lewis Evans 1924.

BIBLIOGRAPHY

Gunther 1932, no. 77, pp. 208-210, fig. 109.

A075 ASTROLABE BY ḌIYĀ AL-DĪN MUḤAMMAD, 1069 AH (AD 1658-59)

Diameter 145 mm

PLU: ex-London, Sotheby's (auction 27 April 2005, lot 46; auction 9 April 2008, lot 212)

Figure A075.1 – Front of the astrolabe (© Sotheby's)

COMPONENTS

Body with *kursī* (d. 145), shackle and ring, rete for about 50 stars, 4 plates and pin; the alidade and horse are not visible in the photo, nor are they mentioned in the catalogue.

FRONT

The ring is plain; the shackle is of trifoliate shape with tear-drop like bases. The *kursī* displays a very fine fretwork. The profiles are made up of an ogee rising from the limb, which is followed by a lobe and an ogee, all these topped by a trifoliate finial. Inside the frame created by the profiles is a large flower of five petals on a long stalk, with two leaves on each side. All these parts are richly decorated with fine engravings on the surface.

The limb is divided in 1° and 5° and labelled from 5 to 360. Dotted lines mark the divisions of groups of 6°; in the rete also dotted lines mark the divisions into signs and the subdivisions of 6° degrees.

RETE

The two rings of the Tropic of Capricorn and ecliptic are held together by the equinoctial and solstitial bars, both fully represented, the former with counter changes at its two intersections with the ecliptic and the later without any counter changes. The spaces between the two rings and inside the ecliptic ring are filled with an almost symmetrical arrangement of vines, producing circular loops, which are endowed with a profusion of tulip flowers with flared petals (a motif dear to Muqīm). At the tips of these petals and elsewhere are the named pointers to about 50 fixed stars.

The ecliptic circle is divided into the 12 signs of the zodiac and the divisions are labelled with the names of the respective signs. Each sign is divided into units of 6° and these units are numbered as 6, 12,… 30. The sloping edge of the ecliptic circle is marked with the divisions of 2°. There is a handle on the circumferential band, a little below the west point.

PLATES

There are four plates serving the latitudes 22°, 25°, 32°, 34°, 36°, 38°; ecliptic coordinates and multiple horizons. It is strange that there is no plate for the imperial capitals of Agra and Delhi at 27° and 29°. Possibly one plate is missing.

Geographical Gazetteer

There is a gazetteer engraved inside the mater, but the catalogue does not mention the number of localities represented there.

Back

The rim of the two upper quadrant bears altitude scales divided in 1° and 5° and labelled as 5—90; 90—5. The rim on the lower half is engraved with cotangent scales. In the upper left is a trigonometric quadrant with horizontal parallels for each 1° and dotted for each 5°. A solar quadrant in the upper right displays two curves of the sun's meridian altitude at latitudes 27° and 32°. In the lower half are shadow squares and standard astrological tables.

Inscriptions

Below the horizontal diameter is the astrolabe maker's signature, where the year is given in standard Arabic/Persian numerals as well as *abjad.*

> *ᶜamal aqall al-ᶜibād diyā' al-dīn muḥammad*
> *ibn qā'im muḥammad ibn mullā ᶜīsā*
> *ibn shaykh allāhdād humāyūnī asṭurlābī*
> *lāhūrī fī sanah 1069 hijrī gh-s-ṭ*
>
> 'The work of the least of the servants [of God], Ḍiyā' al-Dīn Muḥammad, son of Qā'im Muḥammad, son of Mullā ᶜĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1069 Hijrī, [in *abjad* 1000+60+9] 1069.'

The year corresponds to AD 1658-59. On the edge of the astrolabe, there is another inscription, probably added by an owner, who is unidentified:

> *ibn muḥammad taqī munajjim muḥammad raḍā munajjim*
>
> 'The son of Muḥammad Taqī, the astronomer, Muḥammad Raḍā, the astronomer.'

Bibliography

London, Sotheby's, auction catalogue of 27.04.2005, lot 46, pp. 66-67; see also auction catalogue of 9 April 2008, lot 212.

A076 ASTROLABE BY ḌIYĀ' AL-DĪN MUḤAMMAD, 1070 AH (AD 1659-60)[414]

Diameter 88 mm

Washington DC, National Museum of American History

CCA 87; Répertoire 20

Figure A076.1 – Geographical Gazetteer (from Gibbs & Saliba 1984)

414 Entry is based on Gibbs & Saliba 1984, pp. 132-134; the geographical gazetteer is added.

Components

Only the mater of this small astrolabe is extant. Body with *kursī* (d. 88), shackle and ring are original. The rete, 5 plates, alidade, pin and horse are later substitutes.

Front

The *kursī* is finely crafted with fretwork. The profiles are made up of a single lobe between two ogees, ending in a trifoliate finial. The surface of the *kursī* is decorated, on both sides, with ornate engravings. On the edges which form the profiles is a continuous chain-like pattern; the fretwork contains intertwined vines with a flower with three petals in the middle.

The limb is graduated in 2° and 6° and labelled separately for each quadrant as 6—90; 6—90; 6—90; 6—90.

Geographical Gazetteer

On the inner side of the mater is engraved a gazetteer of 38 places in two circles. The letters are written upside-down with their tops directed towards the centre of the astrolabe. The zero symbol with loops on both terminals looks like a small pair of scissors.

Table A076-1 Geographical Gazetteer

	Place Name ***asmā' al-buldān***	**L** ***al-ṭūl***	**φ** ***al-ᶜarḍ***
	Outer Circle		
1	Makka Muᶜaẓẓam	77;10	21;40
2	Madīnat Musharrafa	75;20	25;0
3	Miṣr	63;20	30;20
4	Al-Rūm	77;0	39;40
5	Tabrīz	82;0	38;0
6	Bulghār	90;0	49;30
7	Kūfa	79;30	31;30

	Place Name *asmā’ al-buldān*	L *al-ṭūl*	φ *al-ʿarḍ*
8	Baghdād	80;30	33;25
9	Basra	84;0	30;0
10	Shīrāz	88;0	29;36
11	Ardabīl	82;30	38;0
12	Yazd	89;0	32;30
13	Iṣfahān	86;40	32;25
14	Sabzawār	91;30	36;5
15	Ṭūs	94;30	37;0
16	Tūn	92;30	32;30
17	Harāt	94;33	34;30
18	Balkh	101;0	36;41
19	Bukhārā	97;30	39;50
20	Samarqand	99;56	39;37
21	Hurmūz	92;0	25;0
22	Aḥmadābād	108;0	23;15
23	Kābul	104;40	34;30
	Inner Circle		
24	Kashmīr	103;0	35;0
25	Akbarābād	114;0	26;43
26	Shāhjahānābād	113;35	28;39
27	Ajmīr	111;5	24;0
28	Kawāliyār	115;0	26;29
29	Lāhūr	109;20	31;50
30	Qandahār	107;40	33;0

	Place Name *asmā’ al-buldān*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
31	Mūltān	107;35	29;40
32	Khanbāyat	109;4	22;20
33	Bījāpūr	105;30	17;20
34	Ilāhābād	105;34	27;50
35	Kalkanda	114;39	18;4
36	Dhakā Bankālā	130;0	27;0
37	Burhānpūr	109;0	20;31
38	Batnah	120;45	26;40

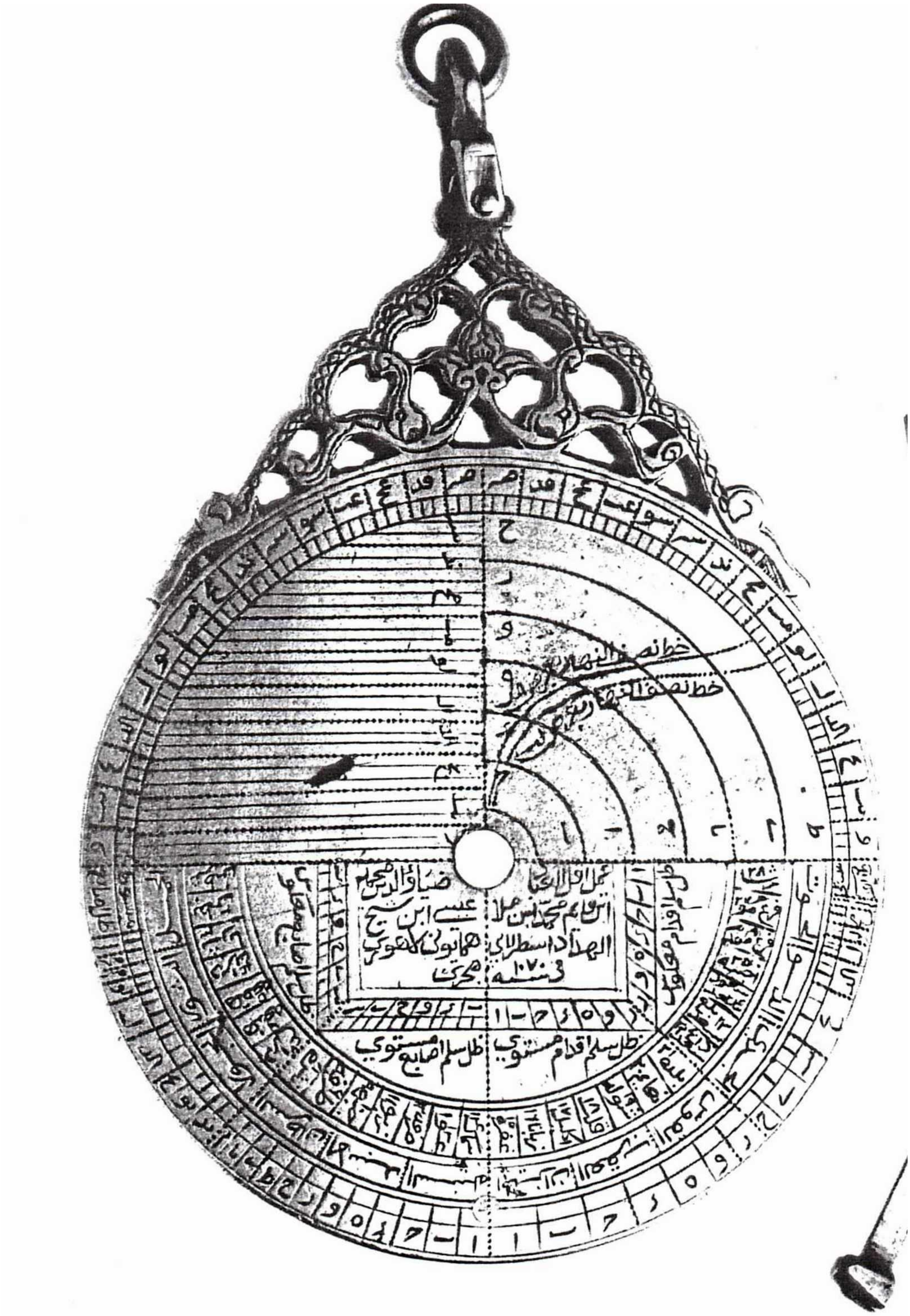

Figure A076.2 – Back of the Astrolabe (from Gibbs & Saliba 1984)

BACK

On the back, the rim of the two upper quadrants carries altitude scales divided in 2° and 6° and labelled as 6—90; 90—6.

The upper left quadrant is engraved with 30 horizontal parallels, i.e., one line for every 2 of 60 parts of the Radius, with every third line dotted. The parallel lines are numbered along the vertical radius as 6, 12, … 60.

The upper right quadrant contains six equally spaced declination arcs, the spaces between them representing a pair zodiac signs. The corresponding signs are marked with their serial numbers (0 to 11) along the two radii. On this grid are plotted two graphs of the solar meridian altitude at the latitudes 27° and 32° with the usual labels.

In the lower half are shadow squares, on the left for a base of 12 and on the right for a base of 7. The related scales are divided and numbered accordingly with the usual labels.

The rim of the lower half carries the cotangent scales, in digits on the left and in feet on the right. In the scale on the left, the unequal divisions are numbered as 1, 2, 3 … 12, 14, 16, 18, 24, 30, 36, 42, 48, 60 followed by the label *ẓill aṣābi*ᶜ. The same set of numbers are engraved on the right half as well, but followed by the label *ẓill aqdām*.

Inside the cotangent scales are two semi-circular rows showing the correlation between the 12 signs of the zodiac and the 28 lunar mansions; the first scale is filled with the names of the 12 signs of the zodiac while the second is filled with the names of the corresponding lunar mansions.

INSCRIPTION

Within the shadow squares is engraved the astrolabe maker’s signature in four lines:

> *ᶜamal aqall al-ᶜibād ḍiyā’ al-dīn muḥammad*
> *ibn qā’im muḥammad ibn mullā ᶜīsā ibn shaykh*
> *allāhdād asṭurlābī humāyūnī lāhūrī*
> *fī sanah 1070 hijrī*
>
> ‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the 1070 Hijrī.’

The others parts, viz., rete, plates, alidade, pin and wedge are crude modern imitations and in some cases non-functional. The rete has an unusual design and the ecliptic circle is not divided into signs and degree. There are several projections

resembling star pointers, but none of these carry star names. Clearly this rete is non-functional. Likewise the five plates are poor imitations.

Therefore Gibbs & Saliba remark: ‘The obvious difference in quality between the body of the astrolabe and the various separable parts suggests that the latter were not work of Ḍiyā’ al-Dīn. The rete unquestionably non-functional. The numbers identifying altitudes on the plate faces do not correspond to specific divisions. There are several stray arcs among the projected hour lines.’

PROVENANCE

Ex-collection of Samuel Verplank Hoffmann, Edgerton, Mass.

BIBLIOGRAPHY

Gibbs & Saliba 1984, p. 35, fig. 23; pp. 132-134, fig. 86, 87.

Gunther 1932, no. 87, p. 216.

A077⊙ ASTROLABE BY ḌIYĀ AL-DĪN MUḤAMMAD, 1071 AH (AD 1660-61) [415]

Diameter 83 mm

Chicago, Adler Planetarium & Astronomy Museum (#A-81)

CCA 2554; Répertoire 22

Figure A077.1 – Front of the astrolabe. Photograph by Stephen Pitkin, Pitkin Studio.
Image © Adler Planetarium, Chicago, IL.

[415] Entry based on Pingree 2009, no. 17, pp. 73-77; the star list has been rearranged according to increasing right ascension.

Components

Body with *kursī* (d. 83, h. 111, t. 6), shackle and ring, rete for 30 stars, 5 plates, uninscribed alidade, washer, pin and wedge.

Front

The ring is plain and the shackle is probably of trifoliate shape. The *kursī* is solid and low with very low, almost flat, lobes in the profiles and with a trifoliate finial. On the front and back are floral decorations in low relief. The limb is divided in 2° and 6°. and labelled from 6 to 90 separately in each quadrant as 6—90; 6—90; 6—90; 6—90.

Rete

The Capricorn and ecliptic rings are held together by complete equinoctial and solstitial bars, the former with two counter changes at the centre and at one of its intersections with the ecliptic in the east, and the latter without any counter changes. Flat handle roughly at the NW point on the ring of the Tropic of Capricorn. The ecliptic circle is divided into the 12 signs of the zodiac and labelled with their names. Each sign is divided into units of 6°, but not numbered. Thorn-like star pointers are joined by vines; 30 of these thorns are engraved with heavily abridged star names.

Table A077-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus*	β Ceti[416]
2	*Fam al-Qayṭus*	γ Ceti
3	*Ṣadr al-Qayṭus*	π Ceti
4	*ᶜAyn al-Thawr*	α Tauri
5	*Yad Jawzā’ al-Yusrā*	γ Orionis
6	*Jawzā’ Yumnā*	κ Orionis
7	*Shiᶜrā Yamānī*	α Canis Majoris

[416] Pingree identifies it as ι Cet, i.e., the northern tip of the tail of Cetus, but what is engraved on this rete is the southern tip, β Ceti.

	Star Name	Identification
8	*Shi*^{c}*rā Shāmī*	α Canis Minoris
9	*Fard al-Shujā*^{c}	α Hydrae
10	*Qalb al-Asad*	α Leonis
11	*Ẓahr Dub*	α Ursae Majoris
12	*Qā*^{c}*idat al-Bāṭiya*	α Crateris
13	*Janāḥ al-Ghurāb*	γ Corvi
14	*Simāk A*^{c}*zal*	α Virginis
15	*Rāmiḥ*	α Bootis
16	*Kiffa Janūbī*	α Librae
17	*Nayyir Fakka*	α Coronae Borealis
18	*Al-Ḥayya*	α Serpentis
19	*Qalb al-*^{c}*Aqrab*	α Scorpii
20	*Rās al-Jāthī*	α Herculi
21	*Rās al-Ḥawwā’*	α Ophiuchi
22	*Nasr Wāqi*^{c}	α Lyrae
23	*Nasr Ṭā’ir*	α Aquilae
24	*Dulfīn*	ε Delphini
25	*Dhanab al-Dajāja*	α Cygni
26	*Fam al-Faras*	ε Pegasi
27	*Dhanab al-Jadī*	δ Capricorni
28	*Sāq Sākib al-Mā’*	δ Aquarii
29	*Mankib Faras*	β Pegasi
30	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are five plates with the following specifications:

Table A077-2 Plates

	φ	Longest day
1a	18°	13;9 hours
1b	22°	13;21 hours
2a	24°	13;32 hours
2b	27°	13;43 hours
3a	29°	13;52 hours
3b	32°	14;8 hours
4a	34°	14;20 hours
4b	36°	14;32 hours
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

On plates 1-4, altitude circles are drawn for every 6°; azimuth arcs are drawn for every 10° below the horizon on all plates except 4b where they are drawn for every 10° above and below the horizon.[417] Plain lines for seasonal hours are traced on all plates. Dotted lines for equal hours are drawn on plates 1 and 2 from both the western and eastern horizons, on 3-4 from the western horizon.

On the tablet of ecliptic coordinates, circles of celestial latitude are drawn for every 6° and numbered from the circle of ecliptic to the north and to the south. Arcs of the celestial longitude are drawn for every 10°; every third of these which marks the boundary between two zodiac signs is dotted. The names of zodiac signs are engraved along the circle of ecliptic and the divisions 10° and labelled. At the north point, there is the label *ṣafīḥat mīzān al-ᶜankabūt.*

417 Pingree states that these are drawn for every 30°, but the photos show otherwise.

On the tablet of horizons half-horizons are drawn for the following latitudes:

6	16	26	...	66
8	18	28	…	58
10	20	30	…	60
12	22	32	…	62

Declination scales are marked along the vertical and horizontal diameters with divisions numbered as 6, 12, 18, 24, implying that the obliquity of the ecliptic is treated here as 24.

Figure A077.2 – Geographical Gazetteer
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

GEOGRAPHICAL GAZETTEER

The gazetteer is engraved in two circles with the latitudes, longitudes and names (in this order) of 38 localities. It does not commence at the south point at the top as is usually done, but below at the north point and proceeds from right to left. The writing is upside down, i.e. the tops of the letters are towards the centre.

Table A077-3 Geographical Gazetteer

	Place Name *asmā’ al-buldān*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
	Outer Circle		
1	Makka Muᶜaẓẓam	77;10	21;40
2	Madīnat Musharraf	75;20	25;0
3	Miṣr	63;20	30;20
4	Ḥalab	72;10	35;50
5	Tabrīz	82;0	38;0
6	Ardabīl	82;30	38;0
7	Bulghār	90;0	49;30
8	Kūfa	79;30	31;30
9	Madā’in	82;0	33;10
10	Baghdād	80;30	33;25
11	Baṣra	84;0	30;0
12	Shīrāz	88;0	29;36
13	Yazd	88;0	32;30
14	Hamadān	83;0	35;10
15	Iṣfahān	86;40	32;25
16	Sabzwār	91;30	36;5
17	Nīshāpūr	92;30	36;21
18	Balkh	101;0	36;41

	Place Name ***asmā' al-buldān***	**L** ***al-ṭūl***	**φ** ***al-ᶜarḍ***
19	Badakhshān	104;24	37;10
20	Bukhārā	97;30	39;50
21	Samarqand	99;56	39;37
22	Kābul	104;40	34;30
23	Qandahār	107;40	33;0
	Inner Circle		
24	Multān	107;35	29;40
25	Lāhūr	109;20	31;50
26	Shāhjahānābād	113;35	28;39
27	Akbarābād	114;0	26;43
28	Ajmīr	111;5	24;0 !
29	Kwāliyār	115;0	26;29
30	Bījāpūr	105;30	17;20
31	Dawlatābād	111;0	21;40
32	Aḥmadābād	108;40	23;15
33	Kalkanda	115;39	18;10
34	Dhākā Bankālā	130;0	27;0
35	Burhānpūr	109;0	20;31
36	Patna	120;45	27;40
37	Kashmīr	103;0 !	35;0
38	Tubbat	110;0	40;0

BACK

The rim of the upper half carries altitude scales which are divided in 2° and 6°, and labelled as 6—90; 90—6. The rim of the lower half bears the scales of cotangents.

In the upper left quadrant are drawn 30 horizontal parallels, i.e., cosines for every 2 of the 60 parts of the Radius, with each third line dotted. The horizontal lines are numbered in 6s from 6 to 60 along the vertical radius.

In the upper right are drawn five arcs of declination so that spaces in between represent a pair of zodiac signs, which are marked with their serial numbers from 0 to 11 along the two radii. Upon the arcs of declination are plotted two graphs of solar meridian altitude for the latitudes of 27° and 32° with the usual labels.

In the lower half are shadow squares, on the left for 7 feet and on the right for 12 digits with the usual labels. The shadow squares are enclosed inside two semi-circular rows in which are inscribed the names of the 12 zodiac signs and those of the 28 lunar mansions. Inside the shadow squares is the maker’s inscription in three lines (see below).

Figure A077.3 – Back of the astrolabe Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

ALIDADE

The plain and ungraduated alidade is a replacement.

Inscription

The inscription is problematic. The engraver appears to have first inscribed the second and the third lines and then added the first line as an after-thought, with the result the astrolabe maker’s genealogy stops with ^{c}Īsā and does not mention Allāhdād; but his two attributes *asṭurlābī humāyūnī* and *lāhūrī* are added at the top of the inscription. The attribute *lāhūrī* fits every member of the family, but *asṭurlābī humāyūnī* is appropriate only for Allāhdād.

humāyūnī lāhūrī

^{c}amal aqall al-^{c}ibād ḍiyā al-dīn muḥammad

ibn qā’im muḥammad ibn mullā ^{c}īsā fī sanah 1071 hijrī

‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of ^{c}Īsā, [son of Allāhdād] of Lahore, [the astrolabe maker to the Emperor] Humāyūn, in the year 1071 Hijrī.’

Figure A077.4 – Signature of the astrolabe maker (detail of Figure A077.3)

Provenance

Ali Kuli Khan, The House of Persian Art, New York, 1941; Adler Purchase 1941.

Bibliography

Pingree 2009, No. 17, pp. 73-77.

A078⊙ ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1071 AH (AD 1660-61)

Diameter 114 mm

London, Nasser D. Khalili Collection of Islamic Art (#SC111)

CCA 2607; Répertoire 24

Figure A078.1 – Back of the Astrolabe (photo by S. R. Sarma)

COMPONENTS

Only the mater is extant, with *kursī* (d. 114, h. 133, t. 7), shackle and ring.

FRONT

The ring has a corrugated edge and the shackle a trifoliate form. As in the previous astrolabe, the *kursī* here also is solid and very low with foliate pattern engraved on both sides. The limb is graduated in 1° and 5° labelled separately for each quadrant as 5—90; 5—90; 5—90; 5—90.

Figure A078.2 – Geographical Gazetteer
(photo by S. R. Sarma)

GEOGRAPHICAL GAZETTEER

The gazetteer provides latitudes, longitudes and place names, in this order, of 54 localities in two circles.[418] It commences from the north point and proceeds clockwise.

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418 Turner 1985, p. 84, states that the *inhirāf* is also given in the gazetteer, but that is not the case.

The shape of the zero symbol here is interesting; at the beginning it is the older form with a single loop; gradually the second loop at the end of the horizontal arm develops; towards the end of the gazetteer it almost reaches the characteristic shape of Ḍiyā’s zero which looks like a small pair of scissors.

Table A078-1 Geographical Gazetteer

	Place Name *asmā’ al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*
	Outer Circle		
1	Makka Muᶜaẓẓam	77;10	21;40
2	Madīnat Musharrafa	75;20	25;0
3	Miṣr	63;20	30;20
4	Al-Rūm	77;0	39;40
5	Tabrīz	82;0	38;0
6	Ardabīl	82;30	38;0
7	Bulghār	90;0	49;30
8	Kūfa	79;30	31;30
9	Baghdād	80;30	33;25
10	Shīrāz	88;0	29;36
11	Yazd	89;0	32;30
12	Qazwīn	85;0	36;55
13	Iṣfahān	86;40	32;25
14	Rayy	86;20	35;0
15	Sabzawār	91;30	36;5
16	Nīshābūr	92;30	36;21
17	Ṭūs	94;30	37;0
18	Tūn	92;30	32;30

	Place Name *asmā’ al-buldān*	L *al-ṭūl*	φ *al-ʿarḍ*
19	Harāt	94;33	34;20
20	Sarakhs	94;30	32;0
21	Marw	97;0	34;40
22	Balkh	101;0	36;41
23	Badakhshān	104;24	37;10
24	Bukhārā	97;30	39;50
25	Samarqand	99;56	39;37
26	Khujand	85;30	41;55
27	Kāshghar	106;30	44;0
28	Hurmūz	92;0	25;0
29	Aḥmadābād	108;40	23;15
30	Ujjayn	102;0	22;30
31	Kābul	104;40	34;30
32	Pānīpatah	113;20	28;52
33	Shāhjahānābād	113;35	28;39
34	Akbarābād	114;0	26;43
35	Ajmīr	111;5	24;0
	Inner Circle		
36	Kawāliyār	115;0	26;29
37	Kashmīr	103;0	35;0
38	Tubbat	110;0	40;0
39	Sarandīp	104;0	10;0
40	Bānāras	117;20	26;52
41	Lāhūr	109;20	31;50

	Place Name ***asmā’ al-buldān***	**L** ***al-ṭūl***	**φ** ***al-ᶜarḍ***
42	Qandahār	107;40	33;0
43	Mūltān	107;35	29;40
44	Nahlawarah ?	102;30	25;0
45	Khanbāyat	109;3	22;20
46	Jidda	76;0	21;0
47	Bījāpūr	105;30	17;20
48	Dawlatābād	111;0	20;30
49	Jawnpūr	119;6	26;36
50	Mansūr Sind	105;0	27;40
51	Burhānpūr	109;0	20;31
52	Patna	120;45	26;40
53	Dhākā Bankāāa	130;0	27;0
54	Kalkanda	114;39	18;4

BACK

The back is engraved almost in the same manner as in the previous two astrolabes (A076, A077). The rim of the upper half bears the altitude scales, divided in 1° and 5° and labelled as 5—90; 90—5. The boundaries of groups of 5° are marked by dotted lines. The rim of the lower half carries cotangent scales.

In the upper left quadrant are drawn 30 horizontal parallels, i.e., one line for 2 of 60 parts of the Radius, with every third line highlighted with dots. Along the vertical radius, these horizontal lines are numbered as 6, 12, …60.

In the upper right quadrant are drawn six dotted declination arcs and the related zodiac signs are marked by their serial numbers (0 to 11) along the two radii. On this grid are plotted two sigmoid graphs of solar meridian altitude for the latitudes 27° and 32° with the usual labels.

In the lower half are drawn the shadow squares, on the left for the base of 12 digits and on the right for the base of 7 feet. The scales on the left are divided into 12 parts (and each part halved) and numbered from 1 to 12; the scales on the right are divided into 7 parts. The scales are accompanied by the usual labels.

In the cotangent scale on the left, the unequal divisions are numbered clockwise from the vertical diameter as 1, 2, 3, …. 8, 10, 12, 15, 18, 21, 24, 30, 42, 48, 60 followed by the label *zill-i aṣābi*[c]; on the right the divisions are numbered anti-clockwise 1, 2, 3, … 8, 10, 12, 15, 18, 24, 30, 36, 42, 48, 60, followed by the label *ẓill aqdām.*

Inside this scale are two semi-circular scales which show the correlation between the zodiac signs and lunar mansions; in the outer semicircle are inscribed the names of the 12 zodiac signs and in the inner semicircle the names of the 28 lunar mansions.

INSCRIPTION

Inside the shadow squares is engraved the astrolabe maker’s signature in three lines.

> *[c]amal aqall al-[c]ibād ḍiyā’ al-dīn muḥammad ibn qā’im muḥammad*
> *ibn mullā [c]īsā ibn shaykh allāhdād asṭurlābī*
> *humāyūnī lāhūrī fī sanah 1071 hijrī*
>
> ‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā [c]Īsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn in the year 1071 Hijrī.’

PROVENANCE

Kinloch Collection: Harriet Wynter, London;
The Time Museum, Rockford, Illinois.

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A079⊙ ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1072 AH (AD 1661-62)[419]

Diameter 182 mm

Paris, PC

CCA 3517; Répertoire 25

Only the mater of this astrolabe survives.

COMPONENTS

Body with *kursī* (d. 182, h. 228, t. 8.5) shackle and ring.

FRONT

Shackle trifoliate, *kursī* fine fretwork with designs engraved on the surface; these are clearly visible on the back; in the front they are worn out.

The limb graduated in 1° and 5° and labelled from 5 to 360. There is a lug at the north point to hold the plates in position. There is a slight crack in the limb at 110°.

GEOGRAPHICAL GAZETTEER

The names, longitudes and latitudes of 116 localities in four circles.

BACK

The rim of the upper two quadrants carries altitude scales which are graduated in 1° and 5° and labelled 5—90; 90—5.

Upper left quadrant has 60 horizontal and 60 vertical parallels, each fifth dotted; these are numbered along both the radii.

Upper right quadrant has declination arcs for every 6° of solar longitude; dotted arcs for every 30° at the boundaries of successive signs. Three sigmoid graphs of solar meridian altitude for the latitudes 27°, 29°, 32° with the usual labels.

In the lower half shadow squares, on the left for the base of 12 and on the right for the base of 7. These shadow squares are enclosed in a series of 8 semi-circular rows. Starting from the outside these rows contain

1-2 cotangents and subdivisions

3-4 the names of the zodiac signs and the names of the lunar mansions

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[419] I saw it briefly in 1994; my photos did not turn out well.

5-6 the limits of the signs (*ḥudūd*)

7-8 decans and their regents (*wujūh*).

INSCRIPTION

Inside the shadow squares is engraved the astrolabe maker’s signature thus:

ᶜamal aqall al-ᶜibād ḍiyā’ al-dīn muḥammad
ibn qā’im muḥammad ibn mullā ᶜīsā ibn shaykh
allāhdād asṭurlābī humāyūnī
lāhūrī fī sanah 1072 hijrī.

‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1072 Hijrī.

PROVENANCE

Ex. Coll. Alain Brieux, Le Val Saint-Germain (Essonne)

A080⊙ ASTROLABE BY ḌIYĀ' AL-DĪN MUḤAMMAD, 1073 AH (AD 1662-63)

Diameter 106 mm

Cambridge, Mass., PC of Professor Owen Gingerich

CCA 3809; Répertoire 26

Figure A080.1 – Front of the Astrolabe (photo by S. R. Sarma)

COMPONENTS

Body with *kursī* (d. 106), rete for 43 stars, 4 plates, alidade and pin and horse. The original horse is missing; a twisted wire is used as the wedge to hold all the components in position. The original shackle and ring are also missing; these are replaced by a small copper ring which passes through the hole at the top of the *kursī* and a very large copper ring which passes through the smaller ring. A long leather strap is tied to the larger ring. The whole thing is placed in a leather pouch.

FRONT

The *kursī* is pierced with 11 large symmetrical holes; the profiles are lobed; trifoliate finial. The limb is divided in 1°, 3° and 6°; the boundary lines for groups of 3° and of 6° are dotted. The scale is labelled as 6—90; 6—90; 6—90; 6—90.

RETE

The two circles of the Tropic of Capricorn and ecliptic are held together by a slender equinoctial bar which has a counter change at the centre. The ecliptic circle is divided into 12 signs of the zodiac and labelled with their names. Each sign is subdivided into 5 units and labelled as 6, 12, 18, 24, 30. The sloped edge is calibrated in 3°. There is a handle on the ring of the Tropic of Capricorn, midway between the north and west points.

The 43 star pointers are joined by an almost symmetrical arrangement of vines. Among the star pointers the motif of tulips (as in Muqīm’s astrolabes) with flared petals occurs occasionally, but generally the star pointers look like thorns projecting out of the vines. The following are the names of 43 stars marked on the rete.[420]

Table A080-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus*	β Ceti
2	*Baṭn al-Ḥūt*	β Andromedae
3	*Fam al-Qayṭus*	γ Ceti
4	*Ṣadr al-Qayṭus*	π Ceti
5	*Ghūl*	β Persei
6	*Tālī Masāfat al-Nahr*	γ Eridani
7	*Dabarān*	α Tauri
8	*ᶜAyyūq*	α Aurigae

[420] The star names are deciphered and identified in Gingerich 1982a, p. 58. Here they are rearranged according to increasing right ascensions.

	Star Name	Identification
9	*Rijl Jawzāʼ Yusrā*	β Orionis
10	*Yad Jawzāʼ [Yusrā]*[421]	γ Orionis
11	*Yad Jawzāʼ[Yumna]*	α Orionis
12	*Rijl Jawzāʼ [Yumnā]*	κ Orionis
13	*Shi*ᶜ*rā Yamānī*	α Canis Majoris
14	*Shi*ᶜ*rā Shāmī*	α Canis Minoris
15	*Fard Shujā*ᶜ	α Hydrae
16	*Rās Asad*	μ Leonis
17	*Qalb al-Asad*	α Leonis
18	*Ẓahr Dub*	α Ursae Majoris
19	*Qā*ᶜ*idat al-Bāṭiya*	α Crateris
20	ᶜ*Anāq*	ζ Ursae Majoris
21	*Janāḥ al-Ghurāb*	γ Corvi
22	*Simāk A*ᶜ*zal*	α Virginis
23	*Simāk Rāmiḥ*	α Bootis
24	*Kiffa Janūbī*	α Librae
25	*Nayyir Fakka*	α Coronae Borealis
26	ᶜ*Unuq al-Ḥayya*	α Serpentis
27	*Qalb al-*ᶜ*Aqrab*	α Scorpii
28	*Rukbat Ḥawwāʼ*	ζ Ophiuchi
29	*Rās al-Jāthī*	α Herculis
30	*Rās Ḥawwāʼ*	α Ophiuchi

[421] Engraved wrongly as *yad jawzāʼ*.

	Star Name	Identification
31	*Yad Ḥawwā’*	δ Ophiuchi
32	*Nasr Wāqi*[c]	α Lyrae
33	*Minqār al-Dajāja*	β Cygni
34	*Nasr Ṭā’ir*	α Aquilae
35	*Dulfīn*	ε Delphini
36	*Dhanab*	α Cygni
37	*Fam Faras*	ε Pegasi
38	*Dhanab al-Jadī*	δ Capricorni
39	*Sāq Sākib al-Mā’*	α Aquarii
40	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
41	*Mankib Faras*	β Pegasi
42	*Surrat [al-Faras]*	α Andromedae
43	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are four plates with the following specifications:

Table A080-2 Plates

	φ	Longest day
1a	22°	13;21 hours
1b	25°	13;25 hours
2a	27°	13;43 hours
2b	29°	13;38 hours
3a	32°	14;8 hours

	φ	Longest day
3b	34°	14;20 hours
4a	18°	13;9 hours
4b	0°+ 72°+ 90°	

On plates 1 to 4a, altitude circles are drawn for every 3° and every fifth line is dotted; azimuth arcs are drawn for every 10° below the horizon and every third line is dotted; and lines for seasonal hours are drawn. Dotted lines for equal hours as counted from the western and eastern horizons are drawn on the plates for 18°, 22° and 25°; dotted lines for equal hours as counted from the western horizon are on the plates for 27°, 29°, 32° and 34°. Plate 4b carries combined projections for the latitudes 0°, 72° and 90°. On all plates *al-maghrib* and *al-mashriq* inscribed at the western and eastern points of the oblique horizon. Strangely there is no plate with the tablet of ecliptic coordinates on one side and the tablet of horizons on the other side.

Geographical Gazetteer

The gazetteer is engraved in two circles, giving the names, longitudes and latitudes of 50 places. The writing is upside down. Much space is left out between the two circles and inside the inner circle.

Figure A080.2 – Geographical Gazetteer (photo by S. R. Sarma)

Table A080-3

	Place Name *Asmā’ al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*
	Outer Circle		
1	Makka Muᶜaẓẓam	77;10	21;40
2	Madīnat Musharrafa	75;20	25;0
3	Miṣr	63;20	30;20
4	Yaman	77;0	11;30
5	Mawṣil	77;0	37;30
6	Tabrīz	82;0	38;0
7	Ardabīl	82;30	38;0
8	Kūfa	79;30	31;30
9	Madā’īn	72;0	33;10
10	Baghdād	80;30	33;25
11	Baṣra	84;30	30;0
12	Shīrāz	88;0	29;36
13	Yazd	89;0	32;30
14	Hamadān	83;0	35;10
15	Karaj	84;45	34;0
16	Qazwīn	85;0	36;55
17	Iṣfahān	86;40	32;25
18	Qum	85;40	34;45
19	Rayy	86;20	35;0
20	Astarābād	89;30	36;50
21	Bustam	89;30	36;10

	Place Name *Asmā’ al-buldān*	L *al-ṭūl*	φ *al-ʿarḍ*
22	Sabzawār	91;30	36;5
23	Nīshābūr	92;30	36;21
24	Ṭūs	94;30	37;0
25	Tūn	92;30	32;30
26	Harāt	94;33	34;30
27	Balkh	101;0	36;41
28	Badakhshān	104;25	37;10
29	Bukhārā	97;30	39;50
30	Samarqand	99;56	39;37
31	Khujand	85;30	41;55
	Inner Circle		
32	Hurmūz	92;0	25;0
33	Ujjayn	102;0	22;30
34	Kābul	104;40	34;30
35	Kashmīr	103;0	35;0
36	Mūltān	107;35	29;40
37	Qandahar	107;40	33;0
38	Lāhūr	109;20	31;50
39	Sarhind	111;33	30;30
40	Shahjahānābād	113;0	28;39
41	Akbarābād	114;0	26;43
42	Ajmīr	111;5	24;00
43	Kawāliyār	115;0	26;29
44	Burhānpūr	109;0	20;31

	Place Name *Asmā’ al-buldān*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
45	Dawlatābād	111;0	21;40
46	Bījāpūr	105;30	17;20
47	Ka[l]kanda	117;39	18;4
48	Dhākā Bangal	130;0	27;0
49	Patna	120;45	26;40
50	Bānāras	117;20	26;52

BACK

On the back, the rim of the two upper quadrants bears altitude scales divided in 2° and 6° and labelled as 6—90; 90—6. The boundary lines between groups of 6° are dotted. In the upper left quadrant are drawn 30 horizontal parallels, i.e., cosines of 2 out of 60 parts of the Radius, and every third line is dotted. The spaces between the dotted lines are numbered along the vertical radius as 6, 12, 18, … 60.

In the upper right quadrant six dotted declination arcs divide the quadrant into six zones, one each for a pair of zodiac signs. The related signs are marked with their serial numbers (0 to 11) along the two radii. Upon this grid are plotted two graphs (also in dotted lines) of the solar meridian altitude for the latitudes of 27° and 32° with the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ 32* respectively.

Figure A080.3 – Back of the Astrolabe and the Alidade (photo by S. R. Sarma)

In the lower half are drawn the shadow squares, on the left for a base of 7 feet and on the right for a base of 12 digits. The scales are divided and numbered accordingly, and are accompanied by the following labels:

Vertical scale on the left: *ẓill sullam aqdām ma*[c]*kūs*

Horizontal scale on the left: *ẓill sullam aqdām mustawī*

Horizontal scale of the right: *ẓill sullam aṣābi*[c] *mustawī*

Vertical scale on the right: *ẓill sullam aṣābi*[c] *ma*[c]*kūs.*

The rim on the lower half carries the cotangent scales. In the scale on the left, the unequal divisions are numbered, from the vertical diameter to the horizontal, as 1, 2, 3,

… 8, 10, 12, 14, 16, 18, 24, 30, 36, 48, 60, followed by *ẓill aqdām.* The divisions in the scale on the right are numbered in the same manner, but followed by *ẓill aṣābi*ᶜ.

Inside the shadow squares are two semi-circular scales; the inner one is filled with the names of the zodiac signs and the outer one with the names of the corresponding lunar mansions.

ALIDADE

The alidade carries, on the left hand side, the declination arcs as in the upper right quadrant along with the serial numbers of the zodiac signs; on the right hand side, a sexagesimal scale numbered in 6s as in the upper left quadrant as well as markings for the sundial.

INSCRIPTION

Just below the horizontal diameter is engraved the astrolabe maker’s signature:

> *ᶜamal aqall al-ᶜibād ḍiyā’ al-dīn muḥammad ibn qā’im muḥammad ibn mullā ᶜīsā ibn shaykh allāhdād asṭurlābī humāyūnī lāhūrī*
> *samah 1073*
> ‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, [in] the year 1073 [Hijri].’

PROVENANCE

Professor Gingerich purchased the astrolabe from an Afghan student in the early 1970’s.

BIBLIOGRAPHY

Gingerich 1992a

A081☉ ASTROLABE BY ḌIYĀ AL-DĪN MUḤAMMAD,1073 AH (AD 1662-63)

Diameter 95 mm

Chicago, Adler Planetarium & Astronomy Museum (#A-78)[422]

CCA 2551[423]; Répertoire 01

Figure A081.1 – Front of the astrolabe. Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

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422 Entry based on Pingree 2009, No. 18, pp. 78-81; the star list has been rearranged according to increasing right ascension.

423 CCA wrongly attributes it to Muhi al-Din M[uhammad]; the date 1140/1727 is also wrong. But the source (CAP), the accession number (A-78) and diameter (95) are correct.

This astrolabe has many features which are common to A077: solid *kursī* with floral decoration in low relief, the limb labelled in the same style separately for each quadrant, fully represented equinoctial and solstitial bars in the rete, the gazetteer commencing at the north point and so on. Yet the back of this astrolabe is so poorly engraved that it is inconceivable that the master astrolabist Ḍiyā' al-Dīn engraved it himself. In the upper left quadrant none of the parallel lines are straight, the shadow squares are constructed with crooked lines, the graduations are uneven, the semi-circular scales in the lower half are badly organised, the writing is cluttered and in poor calligraphy! It is difficult to explain the dichotomy. Pingree does not notice it, but the Répertoire does. It does not include this astrolabe in chronological sequence of astrolabes and celestial globe made by Ḍiyā' al-Dīn, but at the end with the serial number '01' and with the remark 'Cet astrolabe est très douteux'.

COMPONENTS

Body with *kursī* (d. 95, h. 126, t. 7), shackle and ring, rete for 33 stars, 5 plates, alidade, pin and horse.

FRONT

The ring is large and plain; the shackle is also plain with circular bases. The *kursī* is rather wide and low with lobed profiles and a trifoliate finial. On both sides of the *kursī* a floral design is engraved in very low relief.

The limb is graduated in 2° and 6°. Single degrees are marked with a dot. The scale is numbered in 6s, separately for each quadrant, as 6—90; 6—90; 6—90; 6—90.

RETE

The two rings of Capricorn and ecliptic are joined by complete equinoctial and solstitial bars, the former with two counter changes at its two intersections with the ecliptic ring, and the latter without any counter changes. The handle affixed to the right of the north point is lost, only the hole remains. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names. Each sign is divided into units of 6°, but not numbered. There are 33 thorn-like star pointers attached to the solstitial bar and to the two rings.

Table A081-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus*	β Ceti
2	*Fam al-Qayṭus*	γ Ceti
3	*Ṣadr [a]l-Qayṭus*	π Ceti
4	*Rās Ghūl*	β Persei
5	*Tālī Masāfat al-Nahr*	γ Eridani
6	*ᶜAyn al-Thawr*	α Tauri
7	*Rijl Jawzā’ Yusrā*	β Orionis
8	*Yad Jawzā’ Yusrā*	γ Orionis
9	*Yad al-Jawzā’ Yumnā*	α Orionis
10	*Rijl Jawzā’ Yumnā*	κ Orionis
11	*Shiᶜrā Shāmī*	α Canis Majoris
12	*Mankhar al-Shujāᶜ*	σ Hydrae
13	*Fard al-Shujāᶜ*	α Hydrae
14	*Ẓahr Dub*	α Ursae Majoris
15	*Qā’idat al-Bāṭiya*	α Crateris
16	*Ẓahr*	δ Leonis
17	*Janāḥ al-Ghurāb*	γ Corvi
18	*Simāk Aᶜzal*	α Virginis
19	*Simāk Rāmiḥ*	α Bootis
20	*Nayyir Fakka*	α Coronae Borealis
21	*ᶜUnuq*	α Serpentis
22	*Qalb al-ᶜAqrab*	α Scorpii
23	*Rās Ḥawwā’*	α Ophiuchi
24	*Nasr Wāqiᶜ*	α Lyrae

	Star Name	Identification
25	*Nasr Ṭā'ir*	α Aquilae
26	*Dhanab Dulfīn*	ε Delphini
27	*Dhanab al-Dajāja*	α Cygni
28	*Fam al-Faras*	ε Pegasi
29	*Dhanab al-Jadī*	δ Capricorni
30	*Dhanab al-Qayṭus*	ι Ceti
31	*Sāq Sākib al-Mā'*	δ Aquarii
32	*Mankib al-Faras*	β Pegasi
33	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are five plates with the following specifications:

Table A081-2 Plates

	φ	Longest day
1a	0° + 90°[424]	
1b	22°	13;21 hours
2a	24°	13;32 hours
2b	27°	13;43 hours
3a	29°	13;52 hours
3b	32°	14;8 hours
4a	36°	14;32 hours
4b	40°	14;54 hours

[424] Pingree 2009, p. 81, says 90°, but it is double projection for 0° and 90°.

	φ	Longest day
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

Plate 1a has the projection of 0° in the upper half and that of 90° in the lower half. In the lower half, below the horizon on the right is inscribed *al-maghrib* and below that *al-ᶜarḍ lah,* ‘there is no latitude.’ On the left, below the horizon is inscribed *al-mashriq* and below that *al-ᶜarḍ tisᶜūn,* ‘the latitude [is] ninety [degrees]’.

On plates 1-4, altitude circles are drawn for every 6° and labelled. Every fifth line (30°) is dotted. On 1b, 2-4, azimuths are drawn for every 10° below the horizon and labelled. Here too every third line (30°) is dotted.[425] On 1b, 2-4, there are plain lines for seasonal hours and dotted lines for equal hours counted from the western and eastern horizons.

On the tablet of ecliptic coordinates (5a) are drawn the arcs of celestial longitudes for every 10° and circles of celestial latitudes for every 6°; the latter are numbered from the ecliptic circle to the north up to the zenith and to the south up to the Tropic of Capricorn. The names of the zodiac signs are inscribed along the ecliptic and the units of 10° are numbered as 10, 20, 30 separately for each sign. In the lower half is the label *ṣafīḥat mīzān al-ᶜankabūt*

On the reverse side is engraved the tablet of horizons with four sets of half-horizons for the following latitudes:

4	12	20	28	36	44	52	60	68
6	14	22	30	38	46	54	62	70
8	16	24	32	40	48	56	64	72
10	18	26	34	42	50	58	66	74;30

There are declination scales along the vertical and horizontal diameters which are labelled as 6, 12, 18, 24. There is no label with the name of the plate.

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425 Pingree 2009, p. 78, says ‘azimuths on Ia (every 10°) and on IIa (every 45°),’ but the photos show otherwise.

GEOGRAPHICAL GAZETTEER

The gazetteer provides the latitudes, longitudes and names (in this order) of 46 localities in two circles without any space in between. The gazetteer commences, not at the south point at the top, but at the north point below and proceeds from right to left, as in A077 of 1660 above. The writing is upside down, i.e., the tops of the letters are towards the centre.

Table A081-3 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
1	Makka Mu[c]aẓẓam	77;10	21;40
2	Madinat Musharrafa	75;20	25;0
3	Miṣr	63;20	30;20
4	Dimashq	70;0	33;15
5	Ḥalab	72;10	35;50
6	Al-Rūm	77;0	39;40
7	Mawṣil	77;0	34;30
8	Tabrīz	82;0	38;0
9	Ardabīl	82;30	38;0
10	Bulghār	90;0	49;30
11	Kūfa	79;30	31;30
12	Madā’in	72;0	33;10
13	Baghdād	80;30	33;25
14	Baṣra	84;0	30;0
15	Shīrāz	88;0	29;36
16	Yazd	89;0	32;30
17	Iṣfahān	86;40	32;25

	Place Name	L	φ
18	Sabzawār	91;30	36;5
19	Nīshābūr	92;30	36;21
20	Balkh	101;0	36;41
21	Badakhshān	104;24	37;10
22	Bukhārā	97;30	39;50
23	Samarqand	99;56	39;37
24	Ṭūs	94;30	37;0
25	Tūn	92;30	32;30
26	Harāt	94;33	34;30
27	Sarakhs	94;30	32;0
28	Khujand	105;30	41;55
29	Kāshghar	106;30	44;0
30	Hurmūz	92;0	25;0
31	Kashmīr	103;0	35;0
	Inner Circle		
32	Kābul	104;40	34;30
33	Qandahār	107;40	33;0
34	Mūltān	107;35	29;40
35	Lāhūr	109;20	31;50
36	Shāhjahānābād	113;35	28;39
37	Akbarābād	114;0	26;43
38	Ajmīr	111;5	24;0 !
39	Kawāliyār	115;0	26;29
40	Bījāpūr	105;30	17;20

	Place Name	L	φ
41	Dawlatābād	111;0	21;40
42	Aḥmadābād	108;40	23;15
43	Kalkanda	114;39	18;10
44	Dhākā Bankālā	130;0	27;0
45	Burhānpūr	109;0	20;31
46	Patna	120;45	26;40

Back

Surprisingly the quality of engraving on the back is very poor: none of the horizontal lines in the upper left quadrant is straight, the shadow squares are constructed with crooked lines and the signature is very brief!

The rim of the upper half carries altitude scales which are divided in 2° and 6° and labelled as 6—90; 90—6. The rim of the lower half bears the scale of cotangents.

In the upper left quadrant are drawn 30 horizontal parallels, with every third line dotted (not consistently); these are numbered in 6s, from 6 to 60, from the centre upwards along the vertical radius.

In the upper right are drawn five arcs of declination so that the spaces in between represent a pair of zodiac signs. Upon these arcs of declination are plotted two graphs of solar meridian altitude. At the top of the quadrant is a label inscribed upside down in two lines: *khaṭṭ niṣf al-nahār bānah* (?) *ᶜarḍ l.w.y.ḥ* (‘line of the midday [altitude] … (?) latitude 36;18’). The location of the label and its text do not make much sense for here are two lines of midday altitude and not just one for the latitude of 36;18°, if that is the purport of the label.

In the lower half are two small shadow squares, on the left for 7 feet and on the right for 12 digits without any labels. The shadow squares are enclosed by 8 concentric semi-circular scales. Some of the rows are accompanied by a label or title in the lower part of the upper right quadrant.

Figure A081.2 – Back of the astrolabe.
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

1. Cotangent scales. In the scale on the left, the divisions are numbered from the vertical diameter to the horizontal diameter as 3, 6, 7, 9, 12, 15, 18, 24, 30, 36, 42. In the scale on the right the divisions are numbered thus: 3, 6, 9, 12, 15, 18, 24, 30, 36, 42, 48, 40!
2. Subdivisions of the scales in 1.
3. Here the divisions are numbered in the reverse direction, starting from the horizontal diameter. The numbers on the left are: 1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 16, 24, 39 (?). The numbers on the right are 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 16, 21, 24, 30, 36, 48, 72.
4. This row carries the label *al-ḥudūd* and contains the bounds of the limits of the signs.
5. This row carries the label *al-wujūh* and contains the regents of the decans (and not the decans themselves).
6. This row contains the names of the 12 signs with the label *al-burūj.*
7. This row contains the names of the planetary regents of the terms (mentioned in row 4 above). There is a label, but I cannot decipher it.
8. This row contains the names of the 28 lunar mansions, although the label once again undecipherable.

Clearly these scales are badly organised; in other astrolabes, the rows containing the names of the signs and the names of the lunar mansions are placed together; the rows containing the bounds of the terms and the planetary lords of the terms are also placed together. Here they are not. In other astrolabes there are two rows containing the decans and the regents. Here there is only one row with the regents.

INSCRIPTION

ᶜamal ḍiyā' al-dīn muḥammad sanah 1073 hijrī'

'The work of Ḍiyā' al-Dīn Muḥammad, [in] the year 1073 Hijrī.'

PROVENANCE

Sotheby's London 1938; Perry Webster, London 1938; Adler Purchase 1939.

BIBLIOGRAPHY

Pingree 2009, No. 18, pp. 78-81.

A082⊙ SHIP ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, AH 1074 (AD 1663-64)

Diameter 223 mm

Patna, Khuda Bakhsh Oriental Public Library

CCA 1117; Répertoire 27

Figure A082.1 – Front of the Astrolabe (photo by S. R. Sarma)

COMPONENTS

Body with *kursī* (d. 223, h. 297, t. 12), shackle and ring, rete (d.202) for about 42 stars, 4 plates (d. 202), alidade (202 x 11) and pin. The horse is missing.

FRONT

The ring is plain and the shackle is trifoliate. Openwork *kursī* with profiles made up of ogees at the base and at the top with two lobes in between and a trifoliate finial. The surface is filled with ornamental engraving in the front and in the back. The limb is graduated in 1° and 5° and labelled from 5 to 360.

Figure A082.2 – Rete of the Astrolabe (photo by S. R. Sarma)

RETE

In the rete, the two rings of Capricorn and ecliptic are held together by the equinoctial bar which has three counter changes at its two intersections with the ecliptic ring and at the centre. Part of the equinoctial bar coincides with the two mutually

intersecting *zawraqī* horizons drawn for the latitudes of 29° and 32°. A part of the solstitial bar is shown so that it functions as the masts for the two *zawraqī* arcs. The star pointers are joined by a floral tracery. Between the two rings, the tracery looks like a flowering bush; its two braches bearing large leaves and flowers cover the entire space in the east and west. A similar flowering bush is incorporated inside the ecliptic circle as well, but its symmetry is marred by the solstitial bar and the longitudinal slits that run parallel to the bar. There is a large handle just below the western segment of the equinoctial bar.

The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names; each sign is subdivided in groups of 6° and numbered from 6 to 30. The edge of the ring is divided in 1°.

Table A082-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus*	β Ceti
2	*Rijl Musalsala*	γ Andromedae
3	*Fam al-Qayṭus*	γ Ceti
4	*Ṣadr al-Qayṭus*	π Ceti
5	*Rās Ghūl*	β Persei
6	*Mirfaq al-Thurayyā*	α Persei
7	*Kaff al-Jadhmā’*	α Ceti
8	*Tālī Masāfat al-Nahr*	γ Eridani
9	*ᶜAyn al-Thawr*	α Tauri
10	*ᶜAyyūq*	α Aurigae
11	*Rijl Jawjā’ al-Yusrā*	β Orionis
12	*Yad Jawjā’ al-Yusrā*	γ Orionis
13	*Rijl Jawjā’ Yumnā*	κ Orionis
14	*Shiᶜrā Yamānī*	α Canis Majoris
15	*Shiᶜrā Shāmī*	α Canis Minoris

	Star Name	Identification
16	*Ṭarfat Safīna*	ρ Puppis
17	*Fard al-Shujā*[c]	α Hydrae
18	*Qalb al-Asad*	α Leonis
19	*Ẓahr Dubb Akbar*	α Ursae Majoris
20	*Qā’idat al-Bāṭiya*	α Crateris
21	*Ẓahr al-Asad*	δ Leonis
22	*Ṣarfa*	β Leonis
23	*Rās al-Asad*	μ Leonis
24	*Janāḥ al-Ghurāb*	γ Corvi
25	*Simāk al-A*[c]*jal*	α Virginis
26	*Simāk Rāmiḥ*	α Bootis
27	*Kiffa J[anūbī]*	α Librae
28	*Nayyir Fakka*	α Coronae Borealis
29	*Qalb al-*[c]*Aqrab*	α Scorpii
30	*Rās al-Jāthī*	α Herculis
31	*Rās al-Ḥawwā’*	α Ophiuchi
32	*Rukbat al-Rāmī*	α Sagittarii
33	*Minqār al-Dajāja*	β Cygni
34	*Nasr Ṭā’ir*	α Aquilae
35	*Dhanab al-Dulfīn*	ε Delphini
36	*Dhanab al-Dajāja*	α Cygni
37	*Fam al-Faras*	ε Pegasi
38	*Dhanab al-Jadī*	δ Capricorni
39	*Mankib Sākib al-Mā’*	α Aquarii

	Star Name	Identification
40	*Sāq Sākib al-Mā’*	δ Aquarii
41	*Janāḥ al-faras*	γ Pegasi
42	*Surrat al-Faras*	δ Pegasi

Figure A082.3 – Zawraqī Horizons and their Masts in the Rete (photo by S. R. Sarma)

ZAWRAQĪ HORIZONS

Two mutually intersecting arcs are incorporated at the middle of the rete. These are *zawraqī* horizons.[426] Together with the segments of the solstitial bar, they resemble the outlines of ships (*zawraq*) with their masts. The arc with the convex side to the north is the oblique horizon for latitude 29°. The eastern and western halves of the arc carry the labels *ufq mujassam sharqī bi-ᶜarḍ 29* (eastern solid horizon for latitude 29) and *ufq mujassam gharbī bi-ᶜarḍ 29* (western solid horizon for latitude 29) respectively. The

426 On these horizons, see Frank 1920, pp. 18-21.

mast corresponding to this arc, i.e., the solstitial bar above the central hole, has the inscription *shaẓiya yatiru zawraq fawq al-ᶜard* (pointer spanning the *zawraqī* horizons above the earth).

The other arc, with the convex side to the south is the oblique horizon for latitude 32°. Two halves of this arc carry the labels *ufq mujassam sharqī bi-ᶜarḍ 32* (eastern solid horizon for latitude 32) and *ufq mujassam gharbī bi-ᶜarḍ 32* (western solid horizon for latitude 32). Its mast, i.e., the solstitial bar below the central hole, bears the label *shaẓiya yatiru zawraq tahta al-ᶜard* (pointer spanning the *zawraqī* horizons below the earth).

The equinoctial bar carries the labels *mastarat tarbī’ sharqī* (eastern perpendicular rule) in the east *mastarat tarbī’ gharbī* (western perpendicular rule) in the west.

PLATES

There are four plates serving the following latitudes:

Table A082-2 Plates

	φ	Longest day
1a	25°	13;35 hours
1b	27°	13;43 hours
2a	29°	13;52 hours
2b	32°	14;8 hours
3a	34°	14;20 hours
3b	36°	14;30 hours
4a	Tablet of ecliptic coordinates	
4b	Double projection 29° + 32°, to be used with the *zawraqī* horizons	

On plates 1 to 3, altitude circles are drawn for each 1°, every sixth highlighted with dots; azimuth arcs are drawn below the horizon for every 6°; each fifth is highlighted with dots and extended above the horizon. Lines for seasonal hours are drawn on all plates. On plate 1a, dotted lines for equal hours are traced both from the

eastern and western horizons; on the other plates dotted lines for equal hours are drawn from the western horizon. On plate 1a, next to the latitude value of 25° in *abjad* numbers, the number 25 is also engraved in Devanagari numerals. This may have been added later by a Hindu astronomer who did not read the Arabic-Persian script.

The obverse side of the plate is designed as the tablet of ecliptic coordinates. It carries the label *ṣafīḥat mīzān al-ᶜankabūt.* The reverse side of this plate is not prepared as the tablet of horizons as is the usual practice, but as a special tablet to the used along with the *zawraqī* horizons.

Plate 4b to be used with the *Zawraqī* Horizons

Like the other plates, this one is also engraved with the vertical and horizontal diameters, and the three concentric circles of the Tropic of Cancer, the celestial equator and the Tropic of Capricorn.

Around the circle of equator, the twelve astrological houses are marked, once outside the equator and once inside the equator, but with a difference. Outside the equator the enumeration commences from the east point and proceeds counterclockwise, but inside the equator the enumeration commences from the west point and proceeds counterclockwise. The two varying sets of the astrological houses are related to the two oblique horizons engraved on this plate. The names of the astrological houses are engraved in elongated letters so that the names occupy the full stretches of the corresponding houses.

In both cases, each house is divided into 5 units of 6° and the numbers in *abjad* notation are engraved above the names of the astrological houses in Arabic. In Arabic, the first house is named *al-ṭāliᶜ,* ‘the ascendant,’ and the rest are ordinal numbers.

Two mutually intersecting oblique horizons are drawn across the plate. As in the rete, here also the arc with the convex side to the north is the oblique horizon for the latitude 29° and that with the convex side to the south is the horizon of the latitude 32°. Where the arcs intersect with the equinoctial colure, there are labels at the end of each horizon. Thus at the two ends of the horizon for 29° are engraved *ufq sharqī ᶜarḍ 29* (eastern horizon latitude 29) on the east and *ufq gharbī ᶜarḍ 29* (western horizon latitude 29) on the west. Likewise at the two ends of the horizon for 32° are engraved *ufq sharqī ᶜarḍ 32* on the east and *ufq gharbī ᶜarḍ 32* on the west.

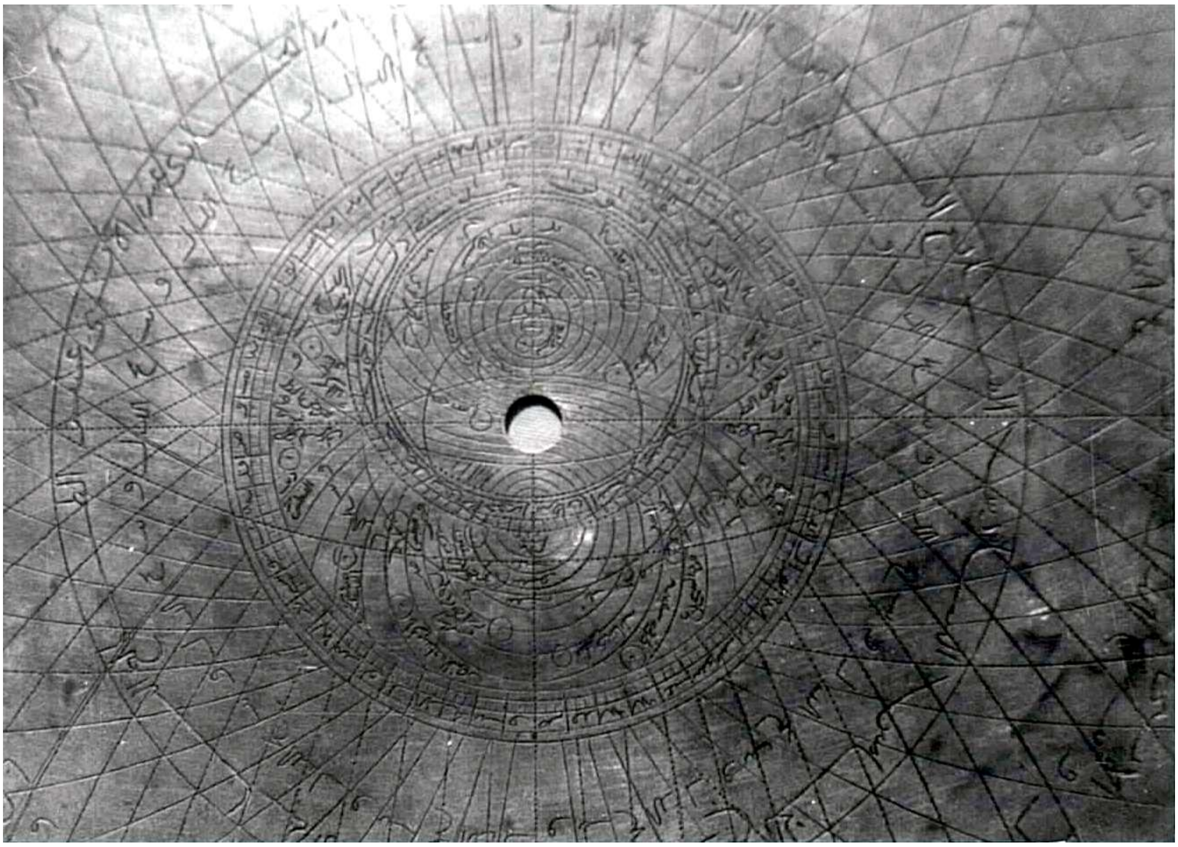

Figure A082.4 – Plate to be used with *zawraqī* horizons, detail (photo by S. R. Sarma)

The rim of the Tropic of Cancer is divided in 360°; each 1° marked and groups of 5° numbered from 5 to 90 counterclockwise, separately for each quadrant. Inside this ring of Cancer a miniature tablet is drawn with smaller versions of the two oblique horizons to match those on the rete, and the corresponding altitude circles. Like the larger horizons drawn across the entire, the oblique horizons in the miniature plate also carry labels on both sides. A circle of ecliptic is drawn; it is divided into the 12 signs and labelled with their names. Several star positons are marked within the Tropic of Cancer with dots enclosed in circles along with their names.

At the bottom of the plate is a long inscription bearing the designation of this special plate: *ṣafīḥat maṭraḥ al-shu*ᶜ*ā*ᶜ *kahtrd* (?) *abī rayhān taswīyat al-buyūt khwānand,* (plate for finding the projection of the astrological rays according to (?) Abū Rayhān [al-Bīrūnī] [and] equalization of the astrological houses).

Geographical Gazetteer

On the inner surface of the mater is engraved a geographical gazetteer with the names, longitudes and latitudes of 128 localities, arranged according to climates in four concentric circles. In the fourth circle, after listing three places which lie beyond the

seventh climate, 15 more places are added without any superscript. These are mainly from the Indian subcontinent and should have been included in the third climate.

Table A082-3 Geographical Gazetteer

	Place Name *asmā’ al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*	
	Outer Circle			
[-I] *az khaṭṭ istiwā’ tā iqlīm awwal* (from the equator up to the first climate)				
1	Sāḥil Baḥr Awqiyānūs	11;0	0;0	
2	Jazīra Qanabala	21;0	3;0	
3	Jamkūt	177;0	5;0	
4	Thala	180;0	5;0	
5	Kūkū	54;10	10;0	
6	ᶜAdan	76;0	11;0	
[I] *al-iqlīm al-awwal* (the first climate)				
7	Jabal	78;0	13;30	
8	Damār	77;15	13;30	
9	Bajja az Barbar	10;0	14;0	
10	Dabīl	74;20	14;10	
11	Ṣanᶜā’ Dar al-Mulk Yaman	77;30	14;30	
12	Janad	75;30	14;30	
13	Sawmnāt	107;0	17;0	Somnath
14	Jaytūn	104;0	17;15	
15	Pijāpūr	105;30	17;20	
16	Burhānpūr	103;0	20;30	
17	Dawlatābād	111;0	20;30	

	Place Name ***asmā’ al-buldān***	**L** ***al-ṭūl***	**φ** ***al-ᶜarḍ***
[II] *al-iqlīm dūyam* (the second climate)			
18	Jadda	76;0	21;0
19	Ṭāᶜif	77;30	21;20
20	Makka Muᶜaẓẓam	77;10	21;40
21	Kanbāyat	109;20	22;20
22	Khybar	75;20	24;20
23	Madīnat Musharrafa	75;20	25;0
24	Hurmūz	92;0	25;0
25	Ajmīr	111;5	26;0
26	Kawalyār	114;0	26;29
27	Lahknawtī	114;33	26;30
28	Qannawj	115;50	26;35
29	Jawnpūr	119;6	26;36
30	Akbarābād Dār al-Khilāfat	114;0	26;43
31	Kūpāmāū	116;33	26;45
32	Kara wa Mānikpūr	118;10	26;49
33	Awadh	118;6	27;22
34	Badāwan	119;19	27;22
[III] *al-iqlīm siwum* (the third climate)			
35	Bakr	105;0	27;40
36	Kūlkanda	114;19	18;4
37	Kūl [wa] Jalālī	114;19	28;4

	Place Name *asmā’ al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*
38	Fīrūzābād	106;30	28;10
39	Sulṭānkūt	115;0	28;30
40	Shāhjahānābād Dār al-Mulk Hind	113;35	28;39
41	Baran	114;0	28;43
42	Pānīpatah	113;20	28;20
43	Shīrāz	88;0	29;36
44	Multān	107;35	29;40
45	Hānsī	112;25	29;55
46	Baṣra	84;0	30;0
47	Kirmān	91;30	30;5
	Second Circle		
tatimma al-iqlīm siwum (continuation of the third climate)			
48	Tānīsar	112;33	30;10
49	Iskandariyya	61;54	30;18
50	Miṣr	63;20	30;20
51	Sanām	112;25	30;30
52	Purshawar	105;55	34;0
53	Kūfa	79;30	31;30
54	Bayt al-Maqdis	66;30	31;50
55	Lāhūr Dār al-Saltanat	109;20	31;50
56	Yazd	89;0	32;0
57	Iṣfahān	87;40	32;25

	Place Name *asmā’ al-buldān*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
58	Qandahār	107;40	33;0
59	Siyālkūt	109;0	33;0
60	Madā’īn	72;0	33;0
61	Dimashq	70;0	33;15
62	Maymand	101;55	33;20
63	Baghdād	82;0 !	33;25
[IV] *al-iqlīm chahārum* (the fourth climate)			
65	Ṭarābulūs	69;40	34;0
65	ᶜĀna	76;0	34;0
66	Kāshān	86;0	34;0
67	Mawṣil	77;0	34;30
68	Tūn	92;30	34;30
69	Harāt	94;30	34;30
70	Kābul	104;40	34;30
71	Qumm	85;40	34;45
72	Rayy	86;20	35;20
73	Sāwa	85;0	35;0
74	Kashmīr	108;0	35;0
75	Hamadān	83;0	35;10
76	Ḥalab	72;10	35;50
77	Mashhad Maqdis	92;30	36;0
78	Sabzwār	91;30	36;5
79	Bisṭām	89;30	36;10
80	Balkh	101;0	36;41

	Place Name *asmā’ al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*	
81	Ṭāliqān	85;45	36;10	
82	Qazwīn	85;0	35;55	
	Third Circle			
tatimma al-iqlīm chahārum (continuation of the fourth climate)				
83	Badakhshān	84;24	37;10	
84	Sarakhs	94;30	37;30	
85	Marw	97;0	37;40	
86	Tabrīz	82;0	38;0	
87	Ardabīl	80;0	38;0	
88	Nakhjawān	81;15	38;40	
[V] *al-iqlīm panjum* (the fifth climate)				
89	Samarqand	99;56	39;37	
90	Bukhārā	97;30	39;50	
91	Tubbat	110;0	40;0	
92	Bardᶜa	83;0	40;30	
93	Samākhī	84;30	40;50	
94	Qūnya	66;30	41;0	
95	Khujand	85;35	41;55	
96	Khutan	107;0	42;0	
97	Kāshān	101;35	42;0	correct Kāsān
98	Farghāna	102;0	42;20	
[VI] *al-iqlīm shashum* (the sixth climate)				
99	Kāshghar	106;30	44;0	
100	Bandqīya	92;0	44;0	

	Place Name *asmā’ al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*
101	Shalkh	85;30	44;0
102	Ṭarāz	99;50	44;31
103	Pashīn Bāligh	111;0	44;50
104	Qarāqūrūm	115;0	46;0
105	Khān Bāligh	124;0	46;0
106	Harqala	67;20	46;30
[VII] *al-iqlīm haftum* (the seventh climate)			
107	Araq	105;0	48;0
108	Bulghār	90;0	49;30
109	Aqjā-kirmān	62;0	50;0
	Fourth Circle		
tatimma iqlīm haftum (continuation of the seventh climate)			
110	Qirqir	65;15	50;0
[VII+] *khāriz al-iqlīm haftum* (beyond the seventh climate)			
111	Jazā’ir Rūdjard	68;50	62;0
112	Mari Kirmān	65;45	50;45
113	Ṣūdaq	66;0	51;0
[Addition without any superscript]			
114	Munkīr	121;45	26;40
115	Ilāhābād	115;35	26;50
116	Sūrat	110;50	20;15
117	Bahraich	117;30	28;0
118	Gūrakhpūr	119;10	27;20
119	Mandu	107;13	22;18

	Place Name *asmā’ al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*
120	Sarandīp	104;0	10;0
121	Bānāras	117;20	26;52
122	Daybal	102;30	25;10
123	Dhākā Bankālā	130;0	27;0
124	Sonār Kāmv	131;0	26;0
125	Bharūj	111;5	21;20
126	Sirhind	111;38	30;30
127	Patnah	120;45	26;40
128	Rūhtas	119;45	26;40

BACK

The rim of the upper half carries altitude scales which are divided in 1° and 5° and labelled as 5—90; 90—5.

The upper left quadrant is engraved with 60 horizontal and 60 vertical parallels of which each fifth is highlighted with dots. These are numbered from 5 to 60 along the two radii.

In the upper right is the solar quadrant with 30 arcs of declination; the names of the corresponding zodiac signs are inscribed along the two radii, together with the numerical values of the subdivisions, viz., 6, 12, 18, 24, 30, separately for each sign. Upon this quadrant are also drawn three sigmoid graphs showing the sun’s meridian altitude in all seasons at the three latitudes of 27°, 29° and 32°. Along the graphs are inscribed the legends, *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27; khaṭṭ niṣf al-nahār bi-ᶜarḍ 29; khaṭṭ niṣf al-nahār bi-ᶜarḍ 32.*

In the lower half are engraved the shadow squares, on the left for a base of 12 and on the right for a base of 7. The vertical and horizontal scales on both sides are divided and numbered accordingly and are endowed with the following labels:

Vertical scale on the left *ẓill sullam aṣābiᶜ maᶜkūs*

Horizontal scale on the left	*ẓill sullam aṣābi*^{c} *mustawī*
Horizontal scale on the right	*ẓill sullam aqdām mustawī*
Vertical scale on the right	*ẓill sullam aqdām ma*^{c}*kūs.*

Inside the shadow squares are engraved two rectangular tables. On the left is the table entitled *jadwal faḍl al-dawr* (excess of revolution) and on the right is the table of triplicities and their nocturnal and diurnal regents (*arbāb muthallathāth laylī wa nahārī*).

Figure A082.5 – Back of the Astrolabe (photo by S. R. Sarma)

The rim of the lower half is engraved with cotangent tables, on the left in digits and on the right in feet. These are followed by 6 semi-circular rows containing the names of the 12 zodiac signs and the names of the 28 corresponding lunar mansions; the table of the limits of the signs and the table of the decan or faces and their regents.

ALIDADE

The alidade is plain without any graduations and has the pin affixed firmly to it. Clearly it is a late replacement.

INSCRIPTION

Immediately below the horizontal diameter is inscribed the astrolabe maker’s signature.

> *ᶜamal aqall al-ᶜibād ḍiyā’ al-dīn muḥammad ibn qā’im muḥammad ibn mullā ᶜīsā ibn shaykh allāhdād asṭurlābī humāyūnī lāhūrī fī 1074 hijrī.*
>
> ‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, astrolabe maker to [the Emperor] Humāyūn.’

BIBLIOGRAPHY

Nadvi 1935; Frank 1920; Sarma 1999c

A083 ASTROLABE BY ḌIYĀ AL-DĪN MUḤAMMAD, 1074 AH (AD 1663-64)

Diameter 52 mm

PLU, ex-London, Sotheby's (catalogue 27 April 2005, lot 47, pp. 68-69).

Figure A083.1 – Astrolabe mater with an endless knot and a pouch (© Sotheby's, London)

With a diameter of just 52 mm, this is probably the smallest astrolabe made by Ḍiyā’ al-Dīn; his uncle Muḥammad Muqīm made a still smaller astrolabe with a diameter of 45 mm (A050). While all the parts of Muqīm’s astrolabe are extant, only the mater survives in the present astrolabe. To the suspensory ring are attached an endless knot and a pouch in red cotton.

The suspensory ring is plain, while the shackle has a trifoliate shape and rather long bases. The *kursī* is quite high and solid. The profiles are made up of a lobe with an ogee below and another above, and topped by a trifoliate finial. On the front of the throne are engraved in a cartouche the words from the Throne Verse of the Qur’ān: ‘[God’s] throne extends over and encompasses the Heavens and Earth.’ The back of the throne is decorated with an ornate design.

The limb is divided in 1° and 6° and labelled from 6 to 90 separately for each quadrant thus: 6—90; 6—90; 6—90; 6—90.

Figure A083.2 – Geographical Gazetteer (detail of Fig. 83.1)

GEOGRAPHICAL GAZETTEER

On the inner surface of the mater is engraved a geographical gazetteer with the longitudes and latitudes of 15 places.[427] From the photo in the catalogue, the following place names and longitudes can be deciphered; the latitudes are too faint to read.

Table A083-1 Geographical Gazetteer

	Place name	L
5	Yazd	89;0
6	Iṣfahān	86;40
7	Ṭūs	94;30
8	Balkh	101;0
9		
10	Kābul	104;40
11	Kashmīr	
12	Lāhūr	

BACK

Probably the rim of the upper two quadrants carries an altitude scale which is divided in 1° and 6° as in the front and labelled as 6—90; 90—6.

The upper left quadrant has horizontal parallels. According to the catalogue, the solar quadrant on the right has two graphs showing the midday solar altitude at the latitudes of 28° and 32°. The second is the latitude of Lahore, the first is problematic; for Delhi one would expect a graph at 29° and for Agra 27°.

In the lower half are said to be 'shadow squares and circumferential scales for determining the shadows for bases 12 (left) and 7 (right).'

[427] The catalogue states wrongly that there are 17 localities.

INSCRIPTIONS

Inside the shadow squares is the signature of the astrolabe maker:

> *ᶜamal ḍiyā’ al-dīn muḥammad ibn qā’im muḥammad ibn mullā ᶜīsā ibn shaykh allāhdād asṭurlābī humāyūnī lāhūrī fī sanah 1074 hijrī.*
>
> ‘The work of Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1074 Hijrī.’

The year translates to AD 1663-64. On the edge of the astrolabe is inscribed a prayer asking God to bless ‘the fourteen innocents’.

A084⊙ ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1074 AH (AD 1663-64)

Diameter 130 mm

Rampur, Rampur Raza Library (#1345 D)

CCA 2511; Répertoire 30

Figure A084.1 – Front of the astrolabe (photo courtesy Rampur Raza Library)

This elegant and handy astrolabe appears to have been actually employed for observation or teaching, which is evident from the signs of wear and tear, especially on the back. Some of the original parts were lost in course of time and were replaced by substitutes. The ring, the bolt and the winged nut are replacements. A sighting tube was added at a later stage to the original alidade. It is now damaged in the middle and is not functional. Otherwise, the astrolabe is in a good state of preservation. Indeed, some of the plates and the inner side of the mater are in mint condition and shine as if these were gilded. [428]

COMPONENTS

Mater with *kursī* (d. 130, h. 168, t. 8), shackle, rete (d. 115) for 42 stars, 5 plates (d. 116), alidade (120 x 20). The ring, pin and bolt are not original, so also the sighting tube.

FRONT

The *kursī* is highly ornate. Several perforations are cut through the surface of the *kursī,* producing a pattern of intertwined vines and tulip-like flowers with flared ends of the petals. The upper surface is further embellished on both sides by finely engraved patterns. The sides of the *kursī* contain four tiers of gradually diminishing lobes. At the top the *kursī* terminates in a trifoliate finial with a hole in the middle. A shackle, also of trifoliate shape, is attached to the *kursī* by means of a pin at this hole. A small ring passes through this shackle.

The limb carries a degree scale divided in 1° and 5° and labelled from 5 to 360.

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[428] This is an abridged and revised version of the description in Sarma 2003, pp. 34-52.

Figure A084.2 – Rete of the Astrolabe (photo courtesy Rampur Raza Library)

RETE

The rete has a higher copper content and is darker in colour than the plates.[429] The Tropic of Capricorn and the ecliptic are held together by the complete equinoctial bar with three counter changes at its two intersections with the ecliptic circle and at the centre. Originally there must have been a handle at the north-west point but it is now missing, leaving just a hole there.

429 This is a common feature in the Mughal astrolabes, especially in those of small size. High copper content probably makes the plate stronger so that it can be reticulated easily.

The ecliptic is divided into the twelve signs of the zodiac and labelled with their names. Each sign is further subdivided into groups of 6° and marked as 6, 12, …, 30. The outer rim of the ecliptic contains a scale of single degrees. 42 star names can be deciphered on the rete.

Table A084-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab Qayṭus [Janūbī]*	β Ceti
2	*Baṭn Ḥūt*	β Andromedae
3	*Rijl Musalsala*	γ Andromedae
4	*Fam al-Qayṭus*	γ Ceti
5	*Ṣadr al-Qayṭus*	π Ceti
6	*Rās al-Ghūl*	β Persei
7	*Tālī Masāfat al-Nahr*	ε Eridani
8	*ᶜAyn al-Thawr*	α Tauri
9	*ᶜAyyūq*	α Aurigae
10	*Rijl al-Jawzā’ Yusrā*	β Orionis
11	*Yad al-Jawzā’ Yumnā*	α Orionis
12	*Rijl al-Jawxā’ Yumnā*	κ Orionis
13	*Shi ᶜrā Yamānī*	α Canis Majoris
14	*Shi ᶜrā Shāmī*	α Canis Minoris
15	*Fard al-Shujāᶜ*	α Hydrae
16	*Qalb al-Asad*	α Leonis
17	*Rās al-Asad*	μ Leonis
18	*Dubb al-Akbar*	α Ursae Majoris
19	*Qāᶜidat al-Bāṭiya*	α Crateris
20	*Ẓahr al-Asad*	δ Leonis

	Star Name	Identification
21	*Al-Ṣarfa*	β Leonis
22	*Janāḥ al-Ghurāb*	γ Corvi
23	*Simāk A ᶜzal*	α Virginis
24	*Simāk Rāmiḥ*	α Bootis
25	*Kiffa Janūbī*	α Librae
26	*ᶜUnuq al-Ḥayya*	α Serpentis
27	*Rukbat al-Ḥawwā'*	μ Ophiuchi
28	*Qalb al-ᶜAqrab*	α Scorpii
29	*Rās al-Jāthī*	α Herculis
30	*Rās al-Ḥawwā'*	α Ophiuchi
31	*Yad al-Ḥawwā'*	δ Ophiuchi
32	*Nasr Wāqiᶜ*	α Lyrae
33	*Minqār al-Dajāja*	β Cygni
34	*Nasr Ṭā'ir*	α Aquilae
35	*Dhanab al-Dulfīn*	ε Delphini
36	*Dhanab al-Dajāja*	α Cygni
37	*Fam al-Faras*	ε Pegasi
38	*Dhanab al-Jadī*	δ Capricorni
39	*Sāq Sākib al-Mā'*	δ Aquarii
40	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
41	*Mankib al-Faras*	β Pegasi
42	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are five plates, each with a diameter of 116 mm. Four of these serve eight different latitudes; the fifth plate is engraved with ecliptic co-ordinates on the obverse and with multiple horizons on the reverse.

Table A084-2

	φ	Longest day
1a	18°	13; 9 hours
1b	22°	13;21 hours
2a	25°	13;35 hours
2b	27°	13;43 hours
3a	29°	13;52 hours
3b	32°	14; 8 hours
4a	34°	14;20 hours
4b	36°	14;32 hours
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

On plates 1-4, equal altitude circles are drawn for each 2° and every fifth circle is highlighted with dots. Azimuth arcs are drawn for each 6° below the horizon and every fifth is highlighted by dots. Lines of seasonal hours are drawn on all plates. In addition, on the plates for 18°, 22°, 25°, lines of equal hours as counted from the western and eastern horizons are drawn, and on the remaining plates, lines of equal hours as counted from the western horizon.

On the tablet of ecliptic coordinates, the circles of celestial latitudes are drawn at intervals of 6° inside the ecliptic and are marked from the ecliptic to the zenith as 6, 12, … 90. Outside the ecliptic they are drawn for every three degrees and numbered from from the ecliptic to the Tropic of Capricorn from 3 to 48. The arcs of the celestial longitudes are drawn at intervals of 6°. The ecliptic circles and the circles of longitude

at the beginning of each zodiac sign are shown in dotted lines. There is a label *ṣafīḥat mīzān al-ᶜankabūt*.

On the reverse side of the above plate is a of multiple horizons, called *ṣafīḥa āfāqī* and this designation is engraved in the lower right quadrant. In each quadrant, half-horizons for ten different latitudes are drawn and labelled where each horizon begins near the circumference and where it ends near the diameter.

These four sets of latitudes are as follows:

6	12	18	24	30	36	42	48	54	60	66;30
7	13	19	25	31	37	43	49	55	61	
8	14	20	26	32	38	44	50	56	62	
9	15	21	27	33	39	45	51	57	63	

Again, in all the four quadrants, declination scales are engraved along the four radii with the values 6, 12, 18, 23;30, the last being the total or maximum obliquity (*al-mayl al-kullī*).

Geographical Gazetteer

On the inner side of the mater is engraved a geographical gazetteer in three annular rings, providing the names, longitudes and latitudes of 77 localities. The data is engraved upside-down.

Figure A084.3 – Geographical Gazetteer (photo courtesy Rampur Raza Library)

Table A084-3 Geographical Gazetteer

	Place Name ***asmā’ al-buldān***	**L** ***al-ṭūl***	**φ** ***al-ᶜarḍ***
	Outer Circle		
1	Makka Muᶜaẓẓam	77;10	21;40
2	Madīnat Musharrafa	75;20	25;0
3	Mahdiyya Maghrib	42;0	32;30
4	Iskandariyya	61;54	30;18

	Place Name *asmā’ al-buldān*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
5	Miṣr	63;20	30;20
6	Ṣanᶜā’ Dār al-Mulk Yaman 77;0	15;30	
7	Dimashq	70;0	33;45
8	Ḥalab	72;10	35;50
9	Al-Rūm	77;0	39;40
10	Jarrān al-Jazīra	73;0	36;40
11	Mawṣil	77;0	34;30
12	Amid	73;40	33;0
13	Marāgha	82;0	36;20
14	Tabrīz	82;0	38;0
15	Ardabīl	82;30	38;0
16	Bardaᶜa	83;0	40;30
17	Bāb al-Abwāb	85;0	43;0
18	Bulghār	90;0	49;30
19	Kūfa	79;30	31;30
20	Madā’in	72;0	33;10
21	Baghdād	80;30	33;25
22	Wāsiṭ	81;30	32;20
23	Baṣrah	84;0	30;0
24	Kāzirūn?	87;0	39;35 !
25	Shīrāz	88;0	29;36
26	Iṣṭakhr	88;30	30;0
27	Yazd	89;0	32;30

	Place Name *asmā’ al-buldān*	L *al-ṭūl*	φ *al-ʿarḍ*
28	Shahrūd	82;20	32;30
29	Hamadān	83;0	35;10
30	Karkh	84;45	34;0
31	Qazwīn	85;0	36;55
32	Iṣfahān	86;40	32;25
33	Rayy	85;40	34;45
34	Qum	86;20	35;0
35	Hausam az Jīlān	85;10	37;0
	Middle Circle		
36	Sabzawār	91;30	36;5
37	Nīshābūr	92;30	36;21
38	Ṭūs	94;30	37;0
39	Tūn	92;30	32;30
40	Harāt	94;33	34;30
41	Sarkhas	94;30	32;0
42	Marw	97;0	34;40
43	Balkh	101;0	36;41
44	Badakhshān	84;24	37;10
45	Bukhārā	97;30	39;50
46	Samarqand	99;56	39;37
47	Khujand	85;30	41;55
48	Kāshghar	106;30	44;0
49	Hurmūz	92;0	25;0
50	Aḥmadābād	108;40	23;55

	Place Name *asmā’ al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*
51	Ujjayn	112;0	22;30
52	Kābul	104;40	34;30
53	Mewāt	107;10	32;50
54	Badā’ūn	114;59	27;32
55	Hānsī	102;25	29;15
56	Samāna (?)	110;30	28;30
57	Tānīsar	112;43	30;10
58	Pānīpatah	113;20	28;52
59	Sunām	110;25	30;30
60	Akbarābād	114;0	26;43
61	Shāhjahānābād	113;35	28;39
62	Ajmīr	111;5	24;0
	Inner Circle		
63	Bījāpūr	105;30	17;20
64	Burhānpūr	103;0	20;30
65	Dawlatābād	111;0	20;30
66	Bayt al-Maqdis	66;30	31;50
67	Lāhūr	109;20	31;50
68	Multān	107;35	29;40
69	Qandahār	107;40	33;0
70	Kalkanda	114;39	18;10
71	Dhākā Bankālā	130;0	27;0
72	Sarandīb	104;0	10;0
73	Kashmīr	108;0	35;0

	Place Name *asmā’ al-buldān*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*
74	Kawāliār	115;0	26;29
75	Bānāras	117;20	26;52
76	Sirhind	111;33	30;30
77	Patna	120;45	26;40

BACK

On the back, the rim of the two upper quadrants carries the altitude scales divided in 1° and 5° and labelled as 5—90; 90—5. In the upper left quadrant are drawn 60 horizontal parallels with every fifth highlighted with dots. These are numbered from 5 to 60 along the vertical radius, starting from the centre.

In the upper right quadrant are drawn declination arcs, one for each 10° of solar longitude, with every third arc highlighted with dots. The names of the corresponding zodiac signs, together with their divisions of 10°, 20° and 30°, are engraved along the two radii. Upon these arcs are superimposed three sigmoid curves which show the sun’s meridian altitude throughout the year at the three terrestrial latitudes of 27°, 29° and 32° with the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27, … 29, … 32.*

Figure A084.4 – Back of the Astrolabe (photo courtesy Rampur Raza Library)

In the lower half, below the horizontal diameter, are engraved the shadow squares, on the left for a base of 12 and on the right for a base of 7. The vertical and horizontal

scales are divided and numbered accordingly. The vertical scale on the left is labelled as *ẓill sullam aṣābi*^{c} *ma*^{c}*kūs* (the scale of reverse shadows in digits) and the horizontal scale as *ẓill sullam aṣābi* ^{c} *mustawī* (the scale of direct shadows in digits). Likewise the vertical scale on the right is labelled as *ẓill sullam aqdām ma*^{c}*kūs*, (the scale of the reverse shadows in feet) and the horizontal scale is designated as *ẓilli sullam aqdām mustawī* (the scale of the direct shadows in feet).

Inside the shadow squares is the table designated as *jadwal faḍl al-dawr* (table of excess of revolution) showing the multiples of the difference (in minutes and seconds) between the approximately correct length of the tropical year and 365 days.

The space between these shadow squares and the outer periphery is divided into eight semi-circular rows. The outermost row situated on the rim contains cotangent scales: on the left in digits and on the right in feet. In the scale to the left, there are unequal divisions which are labelled (starting from the centre and proceeding leftwards) as 1, 2, 3, … 12 / 13, 14, 16, 18, 21, 24, 30, 36, 42, 48, 54, 60, followed by the label *zilli aṣābi*^{c} *mabsūṭ.* The unequal divisions on the right are numbered from the centre to the right, as 1, 2, 3, … 7 / 8, 9, 10, 11, 12, 14, 16, 18, 21, 30, 40, 50, 60, followed by the label *ẓill aqdām mabsūṭ.* The next semi-circular row displays subdivisions of certain divisions in the previous scale, especially, those in the latter half.

The cotangent scales are followed by two rows carrying the names of the 12 zodiac signs and 28 lunar mansions respectively. The two rows that follow contain a table of the limits (*ḥudūd*) and the last two rows the decans and their regents.

ALIDADE

The alidade has two ornate ends and an ornate centre-piece. Two sighting plates are attached perpendicularly to the surface of the alidade. These plates contain two holes each. The smaller hole is for sighting in the daytime and the larger one for observing the stars at night. Into the larger hole a sighting tube was inserted at a later time. The metal content in the tube is quite different from that in the alidade, which is evident from the difference in the colour. The tube is slightly broken in the middle and cannot be used any more for observation.

The upper edge of the alidade is bevelled. The right half is divided into 60 divisions and each fifth is numbered. These divisions match exactly with the 60 divisions on the vertical radius of the upper-left quadrant. In the lower half are marked unequal divisions

numbered from the sighting plate towards the centre from 1 to 6 and in the reversed direction from 7 to 12. These are markings to be used when the alidade is employed as a sundial. The shadows thrown by the sighting plate on the length of the alidade are measured in seasonal hours by these units in the forenoon or afternoon as the case may be.

The upper edge of the left half is divided into six parts, which are further subdivided into three parts each. These six main divisions are further extended as arcs upon the surface of the alidade. On these arcs are engraved the names of a pair of zodiac signs one below the other: *al-jawjā’ / al-saraṭan; al-thawr / al-asad* and so on. These arcs match exactly with the arcs on the upper right quadrant and the names of the signs are the same as those engraved in the quadrant.

INSCRIPTION

The maker’s signature is engraved on either side of the central hole just below the east-west line. Because the alidade rotated tightly around the hole, certain letters close to the hole are rubbed off and cannot be read now. However, since the inscription is composed in a formula-like style and occurs in the same wording in all the astrolabes and celestial globes crafted by Ḍiyā’ al-Dīn, the missing letters can be inferred. The letters containing the name of the maker and the date are intact. Thus the inscription reads as follows:

> *ᶜamal aqall al- ᶜibād ḍiyā’ al-dīn muḥammad ibn qā’im muḥammad ibn mullā ᶜīsā ibn shaykh allāhdād *** fī sanah 1074 hijrī.*
>
> ‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsa, son of Shaykh Allāhdād *** in the year 1074 Hijrī.’ The year translates to AD 1663-64.

BIBLIOGRAPHY

Dube 1928; Gunther 1932, no. 78a, II, p. 228; Nadvi 1935; Sarma 2003, pp. 34-52.

A085⊙ ASTROLABE BY ḌIYĀ AL-DĪN MUḤAMMAD, 1074 AH (AD 1663-64)

Diameter 113 mm

London, Victoria and Albert Museum (#419-1876)[430]

CCA 1060; Répertoire 31

COMPONENTS

Body with *kursī* (d. 113, h. 147, t. 6.5), shackle, ring and cord, rete for 45 stars, 5 plates, alidade and pin. The horse is missing.

FRONT

A large brown cord, probably modern, is tied to the ring. The shackle, somewhat larger, is of trefoil shape. The *kursī* displays close similarity to that of Ḍiyā' al-Dīn's earlier astrolabe of 1653 (A071) with a pleasing fretwork of intertwining vines and a three-petalled flower in the middle. The profiles are made up of a lobe between two ogees, topped by the trifoliate finial. Ornate engravings on the surface of the front and back. The limb is graduated in 1° and 5° and labelled from 5 to 360.

RETE

The Capricorn and ecliptic rings are held together by the equinoctial bar which has a counter change at the centre. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names; each sign is divided into groups of 6° and these are numbered from 6 to 30; they are further subdivided to 3°. There is a handle on the outer ring, midway between the north and west points. The star pointers are joined by almost symmetrical floral tracery inside the ecliptic circle and outside of it.

PLATES

There are five plates with the following specifications.

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430 Victoria and Albert Museum wrote to me to say that they do not permit publication of private photography of their objects. Therefore, this entry is regretfully without my photos.

Table A085-1 Plates

	φ	Longest day
1a	22°	13;22 hours
1b	25°	13;25 hours
2a	27°	13;43 hours
2b	29°	13;52 hours
3a	32°	14;8 hours
3b	34°	14;20 hours
4a	36°	14;32 hours
4b	40°	14;52 hours
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

Plate 1 is heavier than the rest of the plates. Plate 5 does not fit well into the recess; it appears to be a late replacement. Altitude circles for every 3°, each fifth is dotted; azimuth arcs for every 10° below the horizon; lines of seasonal hours and lines of equal hours.

GEOGRAPHICAL GAZETTEER

The geographical gazetteer is inscribed in two circles in zigzag fashion with the names, longitudes and latitudes of 58 localities.

BACK

The rim of the two upper quadrants carries altitude scales graduated in 1° and 5° and labelled as 5—90; 90—5.

In the upper left quadrant are drawn 30 horizontal lines, with each third dotted. These are numbered along the vertical radius as 6, 12, … 60.

In the upper right quadrant are drawn 18 equally spaced declination arcs. The names of the corresponding signs and degrees of the decans are written along the two

radii. On this grid are plotted two graphs of solar meridian altitude for the latitudes of 27° and 32° with the usual labels.

In the lower half are drawn two shadow squares, on the left for a base of 12 and on the right for a base of 7. The shadow squares are enclosed in eight concentric semi-circular scales containing the cotangent scales, the names of the 12 zodiac signs and the 28 corresponding lunar mansions, limits of the signs, decans and their regents.

ALIDADE

The alidade has ornate ends and an ornate centre-piece. The right arm is engraved with a sexagesimal scale in the upper register and with a scale of seasonal hours in the lower register, while the arm on the left carries a zodiac scale with the names of signs engraved in pairs in each division of the scale.

INSCRIPTION

The astrolabe maker’s signature is inscribed inside the shadow squares:

> *ᶜamal aqall al-ᶜibād ḍiyā’ al-dīn*
> *muḥammad ibn qā’im muḥammad ibn mullā ᶜīsā ibn*
> *shaykh allāhdād asṭurlābī humāyūnī*
> *lāhūrī fī sanah 1074 hijrī.*
>
> ‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1074 Hijrī.’

The Hijrī year corresponds to AD 1663-64.

A086 ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1074 AH (AD 1663-64)

Diameter 101mm

Mosul, al-Basha Mosque

Répertoire 32 lists this astrolabe with the following particulars. It is not known whether this astrolabe exists still in Mosul. No images are available.

BACK

A sine graph in the upper left quadrant and, in the upper right quadrant, declination arcs with the curves showing the midday altitude of the sun at the latitudes 27° and 32°.

INSCRIPTION

> *ᶜamal ḍiyā’ al-dīn muḥammad ibn qā’im muḥammad ibn mullā ᶜīsā ibn shaykh allāhdād asṭurlābī humāyūnī lāhūrī fī sanah 1074 hijrī*
>
> ‘The work of Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1074 Hijrī.’

A087 ASTROLABE BY ḌIYĀ AL-DĪN MUḤAMMAD, AH 1074 (AD 1663-64)

Diameter ?

PLU, ex. Aligarh, Maulana Abu Bakar

CCA 1116; Répertiore 33

In his pioneering survey of the Lahore family of astrolabe makers, Nadvi 1935, p. 629, states that an astrolabe by Ḍiyā' al-Dīn Muḥammad was

'with Maulâna Abu Bakar of Jaunpur (Chairman of Theology, Muslim University, Aligarh). It is comparatively smaller and bears the following legend:-

ᶜamal aqall al-ᶜibād ḍiyā' al-dīn muḥammad ibn qā'im muḥammad ibn mullā ᶜīsā ibn shaykh allāhdād asṭurlābī humāyūnī lahūrī fī sanah 1074 h

(The work of the humblest creature Zîa'u'd-dîn Muḥammad, son of Qâim Muḥammad, son of Mullâ 'Isâ, son of Sheykh Allâh-Dâd, Astrolâbî , Humâyûnî, Lahôrî, dated 1074 A.H.)'

During my long stay at Aligarh Muslim University, I could not locate any descendants of Maulana Abu Bakar, nor find any trace of the astrolabe. Nadvi says that the astrolabe was 'comparatively smaller'. The smallest astrolabe made by Ḍiyā al-Dīn measured 52 mm in diameter and it was made in the same year ah 1074. It came up for auction at Sotheby's on 27 April 2005 (A083). It is difficult to say whether it is the same astrolabe which was in the collection of Maulana Abu Bakar in 1935 at Aligarh.

A088 ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, 1077 AH (AD 1666-67)

Diameter 190 mm

Srinagar, Sir Pratap Singh Museum

Figure A088.1 – Front of the astrolabe (photo by Nazir Ahmad Doshab)

COMPONENTS

Body with *kursī* (d. 190), shackle and ring, rete for 51 stars, 10 plates, alidade, pin, washer; wedge appears to be missing.

FRONT

The ring is plain; the shackle has a trifoliate shape and trifoliate bases. The *kursī* is worked *à jour* with the motif of a three-petalled flower at the centre. Its surface is embellished by engravings. As in other astrolabes by him, the profiles of the *kursī* are made up of ogees at the base and at the top with a lobe in between. Here the ogees and the lobe contain still smaller lobes. The finial is trifoliate.

The circular scale on the limb is divided in 0;30°, 1° and 6° and numbered from 6° to 360°.

RETE

The rete consists of the incomplete ring of the Tropic of Capricorn and the full ring of the ecliptic, both held together by equinoctial bar which is counterchanged at the two intersections with the ecliptic. The space between the two rings and inside the ecliptic ring is filled with asymmetric floral tracery, with stylized tulips with flared petals. The ecliptic ring is broader than that of the Tropic of Capricorn; it is divided into the 12 signs and labelled with their names. Each sign is further subdivided into 6° and numbered as 6, 12, 18, 24, 30. The sloped edge of the ecliptic ring is graduated in single degrees. There are 51 named star pointers which are listed below.

Figure A088.2 – Rete of the Astrolabe (photo by Nazir Ahmad Doshab)

Table A088-1 Stars on the Rete

	Star Names	Identification
1	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
2	*[Rijl al-] Musalsala*	γ Andromedae
3	*Fam al-Qayṭus*	γ Ceti
4	*Ṣadr al-Qayṭus*	π Ceti
5	*[Rās al-]Ghūl*	β Persei
6	*Mirfaq al-Thurayyā*	α Persei

	Star Names	Identification
7	*Kaff al-Jadhmā’*	α Ceti
8	*Tālī Masāfat al-Nahr*	γ Eridani
9	*ᶜAyn al-Thawr*	α Tauri
10	*ᶜAyyūq*	α Aurigae
11	*Rijl Jawzā’ Yusrā*	β Orionis
12	*Yad Jawzā’ Yusrā*	γ Orionis
13	*Yad Jawzā’ Yumnā*	α Orionis
14	*Rijl Jawzā’ Yumnā*	κ Orionis
15	*Shiᶜrā Yamānī*	α Canis Majoris
16	*Shiᶜrā Shamī*	α Canis Minoris
17	*Ṭarafat Safīna*	ρ Puppis
18	?	
19	*Minkhar al-Shujāᶜ*	σ Hydrae
20	*Fard al-Shujāᶜ*	α Hydrae
21	*Qalb al-Asad*	α Leonis
22	*Qāᶜidat al-Bāṭiya*	α Crateris
23	*Ẓahr al-Asad*	δ Leonis
24	?	
25	*Anwār al-Farqadayn*	β Ursae Majoris
26	*Al-ᶜAnāq*	ζ Ursae Majoris
27	*Janāḥ al-Ghurāb*	γ Corvi
28	*Simāk Aᶜzal*	α Virginis
29	*Simāk Rāmiḥ*	α Bootis
30	*Nayyir Fakka*	α Coronae Borealis

	Star Names	Identification
31	*ᶜUnuq al-Ḥayya*	α Serpentis
32	*[Qalb] al-ᶜAqrab*	α Scorpii
33	?	
34	*Rās al-Jāthī*	α Herculis
35	*Rās al-Ḥawwā’*	α Ophiuchi
36	*ᶜAyn al-Tinnīn*	γ Draconis
37	*Yad al-Ḥawwā’ al-Yumnā al-Muqaddam*	δ Ophiuchi
38	*Nasr Wāqīᶜ*	α Lyrae
39	*Minqār al-Dajāja*	β Cygni
40	*Nasr Ṭā’ir*	α Aquilae
41	*Dhanab al-Dulfīn*	ε Delphini
42	*Dhanab al-Dajāja*	α Cygni
43	*Fam al-Faras*	ε Pegasi
44	*Dhanab al-Jadī*	δ Capricorni
45	*[Rukbat?]Dhāt al-Kursī*	δ Cassiopeiae
46	*Sāq Sākib al-Mā’ J[anūbī]*	δ Aquarii
47	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
48	*Mankib al-Faras*	β Pegasi
49	*Surrat al-Faras*	δ Pegasi
50	*Janāḥ al-Faras*	γ Pegasi
51	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are ten plates, perhaps the largest number in the Lahore astrolabes, serving the latitudes 11° to 45° at 2° intervals and the ecliptic coordinates and multiple horizons. There is no double projection, nor a plate calibrated for the latitude of Lahore at 32°.

Table A088-2 Plates

	φ	Longest day
1a	11°	12;40 hours
1b	13°	12;48 hours
2a	15°	13;0 hours
2b	17°	13;6 hours
3a	19°	13;12 hours
3b	21°	13;18 hours
4a	23°	13;25 hours
4b	25°	13;35 hours
5a	27°	13;43 hours
5b	29°	13;52 hours
6a	31°	14;2 hours
6b	33°	14;12 hours
7a	35°	14;23 hours
7b	37°	14;34 hours
8a	39°	14;45 hours
8b	41°	15;0 hours
9a	43°	15;14 hours
9b	45°	15;28 hours
10a	Tablet of ecliptic coordinates	

	φ	Longest day
10b	Tablet of horizons	

The latitude plates (i.e., nos 1 to 9) are almost uniformly calibrated, except in the case of hour lines. On all plates, the south-north and east-west lines, the circles of equator and of the tropics, and the arc of the oblique horizon are drawn. There is a small square-shaped incision at the bottom of the meridian line, to keep the plate firmly inside the mater.

Above the oblique horizon altitude circles are drawn for each single degree; every sixth is highlighted with dots. The altitude circles are numbered on both sides. Azimuth arcs are drawn for every 6°, below the horizon and numbered; these numbers are in a straight line, below the horizon and a little above the lowermost point of the Tropic of Cancer. Every fifth line (i.e., 30°) is dotted and extended above the horizon.

Lines for unequal hours are drawn and numbered from 1 to 12, starting at the western horizon. On plate nos. 1 to 4, lines of equal hours counted from the western and eastern horizons (dotted) are drawn. These are numbered from 1 to 6, from the eastern horizon up to the meridian and again from 1 to 6, from the western horizon up to the meridian. On the other hand, on plates 5 to 9, equal hour lines are drawn from the western horizon and these are numbered from 1 to 12 from the western horizon.

On the tablet of ecliptic coordinates are drawn the equator, the two tropics and the ecliptic. The ecliptic is marked with the names of the twelve zodiac signs. The arcs radiating from the centre are the lines of the celestial longitudes at intervals of 6°; these are numbered from 6 to 30, separately for each zodiac sign, along the ecliptic circle. The circles of celestial latitudes are drawn for each 1° and every sixth circle is dotted. Since the ecliptic circle is also the horizon at this terrestrial latitude of 66;30°, these circles of celestial latitudes are counted from the ecliptic both northwards up to the zenith and southwards up to the Tropic of Capricorn. In the present plate, the numbers of these lines are engraved six times: twice from the zenith towards the bottom of the plate (counting northwards from the ecliptic up to the zenith from 1 to 90 and southwards from the ecliptic up to the Tropic of Capricorn from 1 to 47), twice from the top of the plate where the equator touches the Tropic of Capricorn up to the zenith

from 1 to 90, once in the east from the ecliptic from 1 to 24 eastwards and once in the west from the ecliptic from 1 to 24 wastwards. A little above the north point is the *ṣafīhah mīzān al-ᶜankabūt.*

Figure A088.3 – Tablet of ecliptic coordinates (photo by Nazir Ahmad Doshab)

The reverse side of plate 10 is fashioned as the tablet of horizons with four sets of half-horizons for each degree of latitude from 1° to 90°. These half- horizons are distributed in the four quadrants thus:

1	5	9	…	85	89	90
2	6	10	…	86		90
3	7	11	…	87		90
4	8	12	…	88		90

The horizons are numbered at both ends. The scales of declination are marked along each of the radii between the equator and each of the tropics. These are divided into 30 units and numbered as 6, 12, 18, 24, 30; the numbers starting from the equator and reaching to the tropics. Under each scale is the inscription *taqsīm mayl kullī shamālī* or *janūbī,* ‘division of the maximum declination north’ or ‘south’.

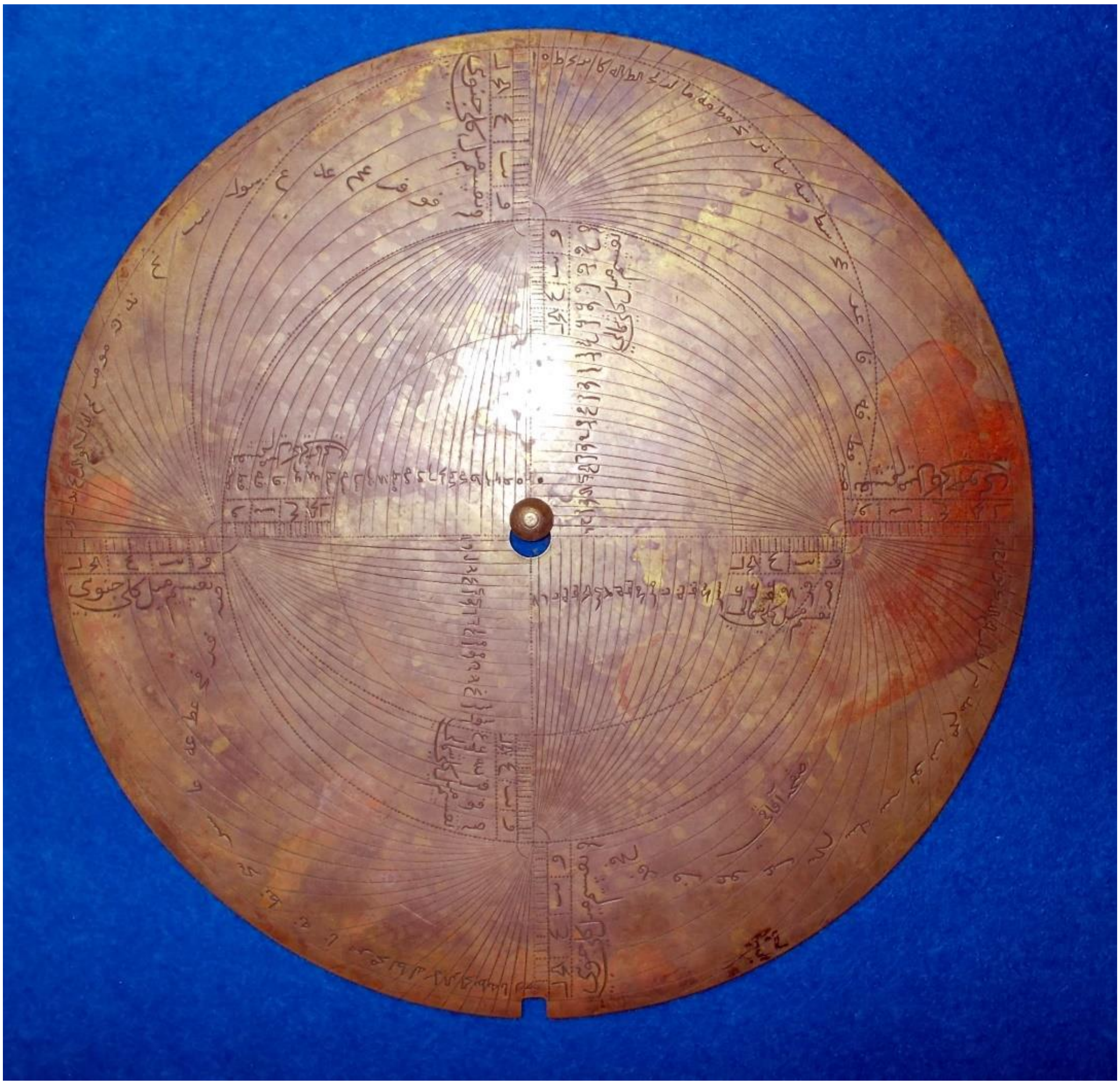

Figure A088.4 – Tablet of horizons (photo by Nazir Ahmad Doshab)

On this small plate, these 90 arcs for each degree are very cleverly distributed in a pleasing symmetric manner so that they do not look cluttered. It requires a great skill on the part of the engraver to draw these 90 arcs here.

Geographical Gazetteer

On the inner side of the mater, the geographic gazetteer is engraved in four annular circles, carrying the names, longitudes and latitudes of 124 localities arranged according

to climates.[431] The circles are separated by double lines and a circle containing the names of relevant climates. The writing is upside-down, i.e., the tops of the letters are towards the centre of the plate.

Figure A088.5 – Geographical Gazetteer (photo by Nazir Ahmad Doshab)

Table A088-3 Geographical Gazetteer

	Place Name	L	φ
	First Circle		

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431 This gazetteer is exactly the same as the gazetteer in the astrolabe made 30 years earlier by Muqīm (A024). At the end of the present gazetteer, Ḍiyā’ al-Dīn adds four names.

	Place Name	L	φ
[-I] *az khaṭṭ istiwā’ tā iqlīm awwal* (from the equator up to the first climate)			
1	Sāḥil Bahr Awqiyānūs	11;0	0;0
2	Jazīra Qanbala	21;0	3;0
3	Jamkūt	177;0	5;0
4	Thala	180;0	5;0
5	Kūkū	54;10	10;0
6	ᶜAdan	76;0	11;0
[I] *al-iqlīm al-awwal* (the first climate)			
7	Jabal	75;0	13;30
8	Dammār	77;15	13;30
9	Bajja az Barbar	10;0	14;0
10	Dabīl	74;20	14;10
11	Ṣanᶜā’ dar al-Mulk Yaman	77;30	14;30
12	Janad	75;30	14;30
13	Sawmnāt	107;0	17;0
14	Zatūn	114;0	17;15
15	Pijāpūr	105;30	17;20
16	Burhānpūr	103;0	20;30
17	Dawlatābād	111;0	20;30
[II] *al-iqlīm dūyum* (the second climate)			
18	Jadda	76;0	21;0
19	Ṭāᶜif	77;30	21;20
20	Makka Muᶜaẓẓam	77;10	21;40

	Place Name	L	φ
21	Kanbāyat	109;20	22;20
22	Khaybar	75;20	24;20
23	Madīnat Musharrafa	75;20	25;0
24	Hurmūz	92;0	25;0
25	Ajmīr	111;5	26;0
26	Kawaliyar	114;0	26;29
27	Lahknawtī	114;33	26;30
28	Qannawj	115;50	26;35
29	Jawnpūr	119;6	26;36
30	Akbarābād	114;0	26;43
31	Kūpāmāū	116;33	26;45
32	Kara wa Mānikpūr	118;10	26;49
33	Awadh	118;6	27;22
34	Badāwan	119;19	27;22
[III] *al-iqlīm siwum* (the third climate)			
35	Bakar	105;0	27;40
36	Kūlkanda	114;19	18;4
37	Kūl [wa] Jalālī	114;19	28;4
38	Fīrūzābād	106;30	28;10
39	Sulṭānkūt	115;0	28;30
40	Shāhjahānābād	113;35	28;39
41	Baran	114;0	28;43
42	Pānīpatah	113;20	28;20
43	Shīrāz	88;0	29;36

	Place Name	L	φ
44	Multān	107;35	29;40
45	Hānsī	112;25	29;55
46	Baṣra	84;0	30;0
47	Kirmān	91;30	30;5
	Second Circle		
[IV] *tatimma al-iqlīm siwum* (continuation of the third climate)			
48	Tānīsar	112;33	30;10
49	Iskandariyya	61;54	30;18
50	Miṣr	63;20	30;20
51	Sunām	112;25	30;30
52	Parshūr	105;55	31;0[432]
53	Kūfa	79;30	31;30
54	Bayt al-Maqdis	66;30	31;50
55	Lāhūr	109;20	31;50
56	Yazd	89;0	32;0
57	Iṣfahān	87;40	32;25
58	Farmal	104;55	32;55
59	Qandahār	107;40	33;0
60	Siyālkūt	109;0	33;0
61	Madā’īn	72;0	33;0
62	Dimashq	70;0	33;15
63	Maymand	101;55	33;20

432 Engraved wrongly as 7;0.

	Place Name	L	φ
64	Baghdād	82;0	33;25
[IV] *al-iqlīm chahārum* (the fourth climate)			
65	Ṭarābulus	69;40	34;0
66	ᶜĀna	76;0	34;0
67	Kāshān	86;0	34;0
68	Mawṣil	77;0	34;30
69	Tūn	92;30	34;30
70	Harāt	94;30	34;30
71	Kābul	104;40	34;30
72	Qumm	85;40	34;45
73	Rayy	86;20	35;20
74	Sāwa	85;0	35;0
75	Kashmīr	108;0	35;0
76	Hamadān	83;0	35;10
77	Ḥalab	72;10	35;50
78	Mashhad Maqdis	92;30	36;0
79	Suharwa[r]d	83;20	36;0
80	Sabzawār	91;30	36;5
81	Basṭām	89;30	36;10
82	Balkh	101;0	36;41
83	Ṭāliqān	85;45	36;10
84	Abhar	84;36	36;45
85	Astarābād	89;35	36;50
86	Qazwīn	85;0	35;55

	Place Name	L	φ
	Third Circle		
[IV] *tatimma al-iqlīm chahārum* (continuation of the fourth climate)			
87	Badakhshān	84;24	37;10
88	Marāgha	82;0	37;20
89	Sarakhs	94;30	37;30
90	Marw	97;0	37;40
91	Tabrīz	82;0	38;0
92	Ardabīl	80;0	38;0
93	Nawshahr	78;20	38;10
94	Nakhjawān	81;15	38;40
[V] *al-iqlīm panjum* (the fifth climate)			
95	Bākūya	84;36	39;30
96	Samarqand	99;56	39;37
97	Bukhārā	97;30	39;50
98	Tubbat	110;0	40;0
99	Bard^{c}a	83;0	40;30
100	Samākhī	84;30	40;50
101	Qūniya	66;30	41;0
102	Khujand	105;35	41;55
103	Khutan	107;0	42;0
104	Kāshān[433]	101;35	42;0
105	Farghāna	102;0	42;20

433 This and the no. 67 earlier are both spelt as ‘Kāshān’. The present one ought to be Kasān, see Kennedy 1987a, pp. 174-75.

	Place Name	L	φ
[VI] *al-iqlīm shashum* (the sixth climate)			
106	Kāshghar	106;30	44;0
107	Bandqīya	92;0	44;0
108	Shalkh	85;30	44;0
109	Ṭarāz	99;50	44;31
110	Pashīn Bāligh	111;0	44;50
111	Qarāqūrūm	115;0	46;0
112	Khān Bāligh	124;0	46;0
113	Harqala	67;20	46;30
	Fourth Circle		
[VII] *al-iqlīm haftum* (the seventh climate)			
114	Araq	105;0	48;0
115	Bulghār	90;0	49;30
116	Aqjā Kirmān	62;0	50;0
117	Qirqir	65;30	50;0
[VII+] *khāriz al-iqlīm haftum* (beyond the seventh climate)			
118	Jazā’ir Rūdjard	68;50	62;0
119	Mārī Kirmān	65;45	50;45
120	Ṣūdaq	66;0	51;0
121	Patnah[434]	120;45	26;40
122	Dhākā Bankālā	130;0	27;0

[434] The last four place names do not occur in Muqīm’s gazetteer mentioned earlier. They should have come in the third climate. Ḍiyā’ al-Dīn adds these here as a kind of post-script. But Kūl (123) has already been mentioned under no. 37 as Kūl [wa] Jalālī.

	Place Name	L	φ
123	Kūl	114;19	28;6
124	Bahrāij	117;30	28;0

BACK

The rim of the two upper quadrants carries altitude scales divided in 1° and 5° and labelled as 5—90; 90—5.

The upper left quadrant bears a sine-cosine graph with 60 horizontal and 60 vertical parallels which are numbered along the two radii from 5 to 60.

The upper right quadrant is divided by 30 quarter circles into as many segments, one each for 6° of solar longitude. The names of the corresponding zodiac signs and the numerical values of their subdivisions (6, 12, 18, 24, 30) are engraved along the two radii of the quadrant. Thus along the vertical radius are engraved, from the centre up to the periphery, the names *al-saraṭān, al-asad, al-sunbula, al-mīzān, al-ᶜaqrab, al-qaws,* i. e. from summer solstice to winter solstice. Likewise along the horizontal radius are engraved, from the periphery up to the centre, the names *al-jadī, al-dalw, al-ḥūt, al-ḥamal, al-thawr, al-jawjā’,* i. e., from winter solstice to summer solstice.

Upon this grid are plotted three sigmoid curves of the meridian altitude of the sun throughout the year at the latitudes 27°, 29° and 32°, which are the latitudes of the three imperial cities of Agra, Delhi and Lahore, with the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27, … 29, … 32.*

In the lower half of the back, immediately below the horizontal diameter, are drawn the shadow squares, on the left for the shadows thrown by gnomon of 12 digits and on the right for the shadows cast by gnomon of 7 feet. The vertical and horizontal scales are divided accordingly into 12 units on the left and into 7 units on the right and numbered.

Figure A088.6 – Back of the Astrolabe (photo by Nazir Ahmad Doshab)

These scales are accompanied by the following labels. Vertical scale on the left: *ẓill sullam aṣabi^c m^{c}akūs* (the scale of the reverse shadows in digits); horizontal scale on the left: *ẓill sullam aṣabi^c mustawī* (the scale of the direct shadows in digits) ;horizontal scale on the right: *ẓill sullam aqdām mustawī* (the scale of the direct shadows in feet), and vertical scale on the right: *ẓill sullam aqdām m^{c}akūs* (the scale of the reverse shadows in feet).

Inside the shadow squares are engraved two rectangular tables. The table to the left of the vertical diameter is entitled *jadwal faḍl al-dawr* (excess of revolution). Here the serial numbers in columns 1 and 3 are given in the standard Arabic/Persian numerals while the numerical values of the differences in minutes and seconds are in *abjad* numerals.

The table on the right carries the heading *jadwal arbāb muthallathāt laylī wa nahārī* and displays triplicities in four sub-tables, each devoted to an element: *nārī wa tarābī* (fiery and earthy) and *hawā’ī wa māhī* (airy and watery).

The rim of the lower half bears the scales of cotangents, on the left in digits and on the right in feet. The unequal divisions in the scale on the left are numbered clockwise from the vertical diameter to the horizontal diameter as 1, 2, 3 … 10, 12, 14, 16, 18, 20, 22, 24, 27, 30, 36, 42, 48, 54, 60 followed by the label *ẓill aṣābi^c mabsūṭ*. Those in the scale on the right are numbered anti-clockwise from the vertical diameter as 1, 2, 3 … 12, 14, 16, 18, 21, 24, 30, 36, 42, 48, 54, 60, followed by the label *ẓill aqdām mabsūṭ*. In a parallel band inside, these divisions in the scales are subdivided into smaller units.

Then follow six concentric semi-circular rows. The first two are engraved with the names of the 12 zodiac signs and the names of the corresponding 28 lunar mansions respectively. The following two rows contain a table of limits (*ḥudūd*) while the last two rows show the decans and their lords.

ALIDADE

Figure A088.7 – Detail of Fig. 88.1 showing the Alidade

The alidade is straight without any counter change. It has pointed ornate ends and a matching ornate centre piece. In the right half, the upper edge is divided into 60 parts and numbered as 5, 10, 15…55, 60, from the centre to the right end, to match the divisions on the upper left quadrant.

The left half of the alidade is designed to match the solar quadrant on the upper right of the back of the astrolabe. It carries 6 arcs, each representing a pair of signs. The names of these signs are engraved in two rows. In the lower row, starting from the centre and proceeding to the end are the six names from *al-Saraṭān* (Cancer) to *al-Qaws* (Sagittarius) and in the upper row, starting from the end and proceeding up to the centre, are the six names from *al-Jady* (Capricorn) to *al-Jawzā’* (Gemini).

Moreover, on the right hand side, below the sexagesimal scale, there is another scale with unequal divisions. These are numbered in *abjad* from the sighting plate onwards from 1 to 6 and in the reverse order from 7 to 11. These are the markings to be used when the alidade is employed as a sundial. The shadow thrown by the sighting plate on the right across the length of the alidade is measured with these numerals to determine the seasonal hours in the forenoon or afternoon as the case may be.

INSCRIPTION

In the narrow space between the rectangular tables and the horizontal diameter is the maker’s signature, engraved in two lines:

> *ᶜamal aqall al-ᶜibād ḍiyā’ al-dīn muḥammad ibn qā’im muḥammad ibn mullā ᶜīsā ibn shaykh allāhdād asṭurlābī humāyūnī lāhūrī fī sanah 1077 hijrī gh-ᶜa-z.*
>
> ‘The work of the least of the servants [of God], Ḍiyā al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1077 of Hijra, [in *abjad*] 1000 + 70 + 7.’

PROVENANCE

The astrolabe was on loan to the Central Asian Museum of the University of Kashmir from 1980 to 2015 February. The authorities of Central Asian Museum, in particular Mr Nazir Ahmad Doshab, kindly provided the measurements and a full set of excellent photos of the astrolabe.

A089 ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, AH 1077 (AD 1666-67)
Diameter ?
PLU
Répertoire 34

The Répertoire mentions the National Museum, Karachi, as the place of deposit of this astrolabe, and provides the following information about the astrolabe. But I have been informed by the museum that this astrolabe does not exist there. It is not known from where the Répertoire gathered the details about this astrolabe.

Only the mater is extant, diameter is not mentioned.

On the back, the upper left quadrant has a graph of sines and cosines; upper right quadrant is divided in 30 parts by the declination arcs, with the names of zodiac signs, three sigmoid curves displaying the midday altitude of the sun at the latitudes of 27°, 29° and 32°.

INSCRIPTION

> *ᶜamal aqall al-ᶜibād ḍiyā’ al-dīn muḥammad ibn qā’im muḥammad ibn mullā ᶜīsā ibn shaykh*
> *allāhdād asṭurlābī humāyūnī lāhūrī fī sanah 1077 hijrī*
> *gh-ᶜa-z*
> ‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, in the year 1077 Hijrī, [the same in abjad notation] 1000+70+7.’

A090⊙ NORTH-SOUTH ASTROLABE BY DIYĀ’ AL-DĪN MUḤAMMAD AH 1085 (AD 1674-75)

Diameter 163 mm

Jaipur, Jai Singh’s Observatory

CCA 2703; Répertoire 36

Figure A090.1 – Obverse side of the astrolabe (photo by S. R. Sarma)

In this north-south astrolabe (*asṭurlāb shamālī wa janūbī*), the obverse side of the single plate is engraved as a latitude plate for 33° N and on it is superimposed a northern projection of the ecliptic circle together with the positions of 46 stars, while the reverse side is designed for latitude 35° N on which a southern projection of the ecliptic circle is drawn and the positions of the same 46 stars, but with southern orientation, are marked. The choice of these latitudes is rather intriguing. There is a minimal rete consisting of just the ecliptic ring and an alidade with a sighting tube.

COMPONENTS

Plate with *kursī* (d. 163, h. 186), shackle and ring, rete, ruler, alidade with a sighting tube, pin and nut. The pin and nut are modern replacements

Obverse Side with the Northern Projection of the Ecliptic

The plain *kursī,* faintly lobed, terminates in a trefoil, to which a small shackle is attached. A small ring passes through the shackle. A small rectangular copper plaque is attached to the ring by means of an iron chain. This plaque was added in Jaipur during the reign of Sawai Madho Singh in the mid-eighteenth century. On this plaque is engraved in Devanagari script *yaṃtrarāja do ṭo patra ek ko,* which translates roughly to ‘astrolabe, two latitude plates in one.’

The rim of the plate is graduated into groups of 6° and labelled separately for each quadrant with *abjad* numerals as 6, 12, … 84, 90, in clockwise direction. In the upper right quadrant, however, groups of 6° are numbered, in addition to the *abjad* numerals, also in common Arabic/Persian numerals from 6 to 90, but proceeding in the reverse direction from the west point up to the south point, for measuring the angles of altitude. These groups of 6° are further subdivided into single degrees of arc, where each third line is highlighted by dotted lines. Vertical and horizontal diameters are also represented by dotted lines.

Inside the circular scale are drawn the Tropic of Capricorn, the equator and the Tropic of Cancer, one inside the other, each as a pair of concentric circles. The oblique horizon is shown with a dotted line. Above the western end of the oblique horizon is written *al-maghrib* and above the eastern end *al-mashriq.* Above the oblique horizon are traced a series of altitude circles, drawn for every 6°. They are numbered in *abjad* numerals on both sides of the meridian. Each third altitude circle is highlighted with

dots. There are no azimuth arcs. Below the oblique horizon are engraved the latitude for which the plate is calibrated and the maximum length of the daylight at this latitude: *al-ᶜarḍ 33 sāᶜāt*--. The value of the maximum duration is difficult to decipher. In the lower half are the lines of seasonal hours, counted from the western horizon in *abjad* numerals.

Below the oblique horizon and almost parallel to it are a pair of arcs, one plain and the dotted. The plain arc is about 18° from the horizon and the dotted one is roughly at 24° from the horizon. These appear to be the arcs of the *ṣubḥ-i sādiq* (the true dawn) and of the *ṣubḥ-i kāẓib* (false dawn) respectively. In the rete there is a reference to the *ṣubḥ-i sādiq*.

Upon all these circles is superimposed the ecliptic circle, touching the south point of the Tropic of Cancer and the north point of the Tropic of Capricorn. It is divided into the 12 zodiac signs and labelled with the names of the signs, starting from the vernal equinox at the east point and proceeding anti-clockwise. Each sign is further subdivided into groups of 6° and numbered in common Arabic/Persian numerals in the anti-clockwise direction.

Finally, the entire surface of the plate is marked with 46 star positions with dots enclosed in small circles and labelled with the names of the stars. These names are listed below in the order of increasing right ascension, starting from the vernal equinox at the east point.

Table A090-1 Stars on the Obverse Side of the Plate

	Star Name	Identification
1	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
2	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
3	*Rijl Musalsala*	γ Andromedae
4	*Fam al-Qayṭus*	γ Ceti
5	*Ṣadr al-Qayṭus*	π Ceti
6	*Rās al-Ghūl*	β Persei

	Star Name	Identification
7	*Kaff al-Jadhmā’*	α Ceti
8	*Tālī Masāfat al-Nahr*	γ Eridani
9	*ᶜAyn al-Thawr*	α Tauri
10	*ᶜAyyūq*	α Aurigae
11	*Rijl al-Jawzā’ al-Yusrā*	β Orionis
12	*Yad al-Jawzā’ al-Yusrā*	γ Orionis
13	*Yad al-Jawzā’ al-Yumnā*	α Orionis
14	*Yad al-Jawzā’ al-Yumnā*	κ Orionis
15	*Shiᶜrā Yamānī*	α Canis Majoris
16	*Ṭarfat al-Safīna*	ρ Puppis
17	*Shiᶜrā Shāmī*	α Canis Minoris
18	*Nathra Saḥābī*	ε Cancri
19	*Fard al-Shujāᶜ*	α Hydrae
20	*Qalb al-Asad*	α Leonis
21	*Rās al-Asad*	μ Leonis
22	*Ẓahr Dubb Akbar*	α Ursae Majoris
23	*Qāᶜidat al-Bāṭiya*	α Crateris
24	*Ṣarfa*	β Leonis
25	*Anwār al-Farqadayn*	β Ursae Majoris
26	*ᶜAnāq*	ζ Ursae Majoris
27	*Janāḥ al-Ghurāb*	γ Corvi
28	*Simāk Aᶜzal*	α Virginis
29	*Simāk Rāmiḥ*	α Bootis
30	*Kiffa J[anūbī]*	α Librae

	Star Name	Identification
31	*Kiffa Sh[amālī]*	β Librae
32	*Nayyir Fakka*	α Coronae Borealis
33	*ᶜUnuq al-Ḥayya*	α Serpentis
34	*Qalb al-ᶜAqrab*	α Scorpii
35	*Rukbat al-Ḥawwā’ Yusrā*	ζ Ophiuchi
36	*Rās al-Ḥawwā’*	α Ophiuchi
37	*ᶜAyn Tinnīn*	γ Draconis
38	*Yad al-Ḥawwā’*	δ Ophiuchi
39	*Nasr Wāqiᶜ*	α Lyrae
40	*Dhanab al-Dajāja*	α Cygni
41	*Fam al-Faras*	ε Pegasi
42	*Dhanab al-Jadī*	δ Capricorni
43	*Sāq Sākib al-Mā’*	δ Aquarii
44	*Mankib al-Faras*	β Pegasi
45	*Kaff al-Khaḍīb*	β Cassiopeiae
46	*Surrat al-Faras*	δ Pegasi

Figure A090.2 – Reverse side of the astrolabe with the sighting tube (photo by S. R. Sarma)

Reverse Side with the Southern Projection of the Ecliptic

The rim of the plate is graduated into groups of 6° and numbered continuously from 6 to 360 in *abjad* numerals in clockwise direction. In the upper right quadrant, the

groups of 6° are numbered also with the standard Arabic numerals from 6 to 90 from the west point up to the south point, as is done on the obverse side. Also as on the obverse side, groups of 6° are further subdivided into single degrees of arc, where each third line is highlighted by dotted lines. Vertical and horizontal diameters are also represented by dotted lines.

Since this side carries southern projections, the two tropics change places. Therefore here the Tropic of Cancer, the equator and the Tropic of Capricorn are drawn one inside the other. The oblique horizon is shown with a dotted line. Above the western end of the oblique horizon is written *al-maghrib* and above the eastern end *al-mashriq*. Above the oblique horizon are a series of altitude circles, drawn for every 6°. They are numbered in *abjad* numerals on both sides of the meridian. Each third altitude circle is highlighted as a dotted line. There are no azimuth arcs. Below the oblique horizon are engraved two labels on either side of the meridian. That on the right reads *al-ᶜarḍ 35* (latitude 35°) and that on the left *sāᶜāt 14;25* ([maximum duration of the daylight] 14;25 hours). There are also lines for seasonal hours, counted from the western horizon in *abjad* numerals.

As on the obverse side, here also two twilight arcs, one plain and the other dotted, are drawn below the oblique horizon at 18° and 24° from it.

In the lower half is drawn the ecliptic circle so that it touches the north point of the Tropic of Cancer and the south point of the Tropic of Capricorn. It is divided into the 12 zodiac signs and labelled with the names of the signs, starting from the west point and proceeding anticlockwise. Each sign is further subdivided into groups of 6° and numbered in standard Arabic numerals in the anti-clock direction. Finally the entire surface of the plate is marked with the same set of 46 star positions as on the obverse sides, but with their positions changed by about 180° due to the southern orientation.

RETE

The rete which can be used on either side is reduced to the bare minimum of the ecliptic ring, which has a diameter of 100 mm. Inside the ring are a north-south and an east-west bar which intersect at the centre of the astrolabe. Near the intersection, a small ring is attached to the two bars for the pin to pass through. The ecliptic ring is divided into the 12 signs of the zodiac and engraved with their names, starting from the vernal equinox at the east point and proceeding anticlockwise. Each sign is further subdivided

into groups of 6°. These are labelled separately for each sign as 6, 12, 18, 24, 30 in *abjad* notation in anti-clock direction. On the upper part of the north-south bar, there is a handle, trifoliate in outline, to facilitate the rotation of the rete. At the south point, there projects a small pointed Capricorn index (*al-mūrī*). Above this rete rotates a ruler with a pointed terminal, but otherwise plain.

The north-south bar is divided in groups 6 units and these are marked unevenly from the south point up to the centre. The first two units are not numbered, those from the third are numbered as 6, 6, 12, 18, … 90. On the eastern half of the east-west bar *ayn waqt subaḥ-i sādiq numā* (this is the indicator of the time of the true dawn).[435] It is presumed that this rete would be used in combination with the two arcs engraved below the horizon on both sides of the plate.

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435 I am grateful to Mr Mubashir Al-Huq Abbasi for this translation and explanation: *ṣubḥ-i sādiq* means the true morning, the time between sun rise and when sun is 18° below the horizon, as against the *ṣubḥ-i kāẓib,* ‘the first or false dawn’.

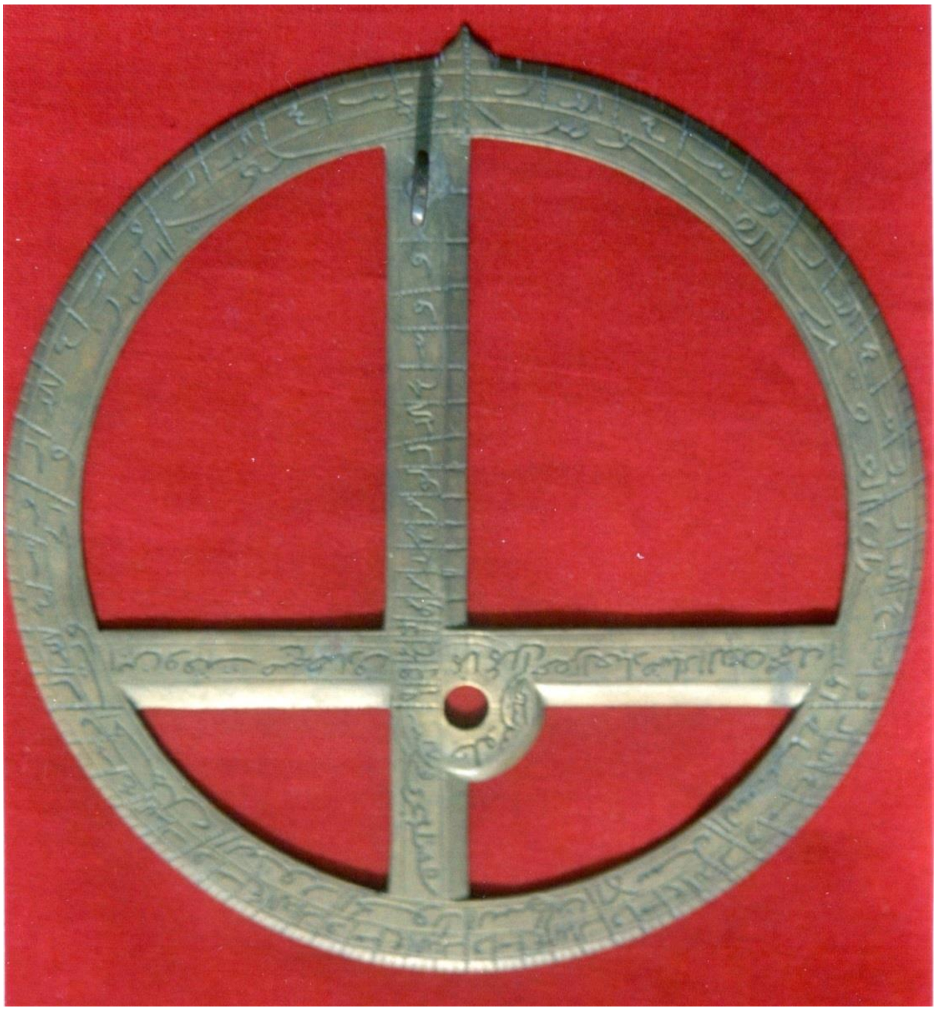

Figure A090.3 – The minimal rete (photo by S. R. Sarma)

SIGNATURE OF THE ASTROLABE MAKER

The signature is engraved on the left half of the east-west bar and continued on the upper half of the north-south bar and concluded on the central ring:

> *ᶜamal aḥqar al-ᶜibād ḍiyā’ al-dīn muḥammad sanah 1085 hijrī wa sanah 18 julūs mubārak.*
>
> ‘The work of the most wretched servant [of God], Ḍiyā’ al-Dīn Muḥammad, [in] the year 1084 Hijrī and the year 18 of the blessed reign [of the Emperor Aurangzeb].’

Figure A090.4 – Signature of the astrolabe maker (detail of Figure A090.3)

ALIDADE AND SIGHTING TUBE

On the back of the astrolabe is attached a straight-bar alidade (length 150 mm) with a centre-piece through which the pin passes. Diyā al-Dīn’s subtle art of ornamentation can be seen in the fact that the tapering ends of the alidade are fashioned to match the profiles of the centre-piece and the profiles of the *kursī.* A sighting tube is attached to this alidade with supports at either end. This is one of the few instances where a sighting tube is attached to the alidade in the Lahore astrolabes. On the right hand side of the alidade, the sloped rim between the centre and the support for the sighting tube is divided into 21 units and numbered in 7s as 7, 14, 21 from the support up to the centre. The significance of this numbering is not understood.

The components are held together by a broad-headed bolt and a winged nut which are not original.

PROVENANCE

The astrolabe appears to have been acquired by Sawai Jai Singh in the first quarter of the eighteenth century, along with a number of other important astrolabes of the Lahore family such as the zoomorphic astrolabe attributable to Muqīm (A051) and Ḍiyā’ al-Dīn’s A072 and A091. Most probably during the time of his son Sawai Madho Singh in the mid-eighteenth century, copper plaques with the description or functions of the instruments were attached.

BIBLIOGRAPHY

Turner 1985, p. 78 and figure 58.

A091⊙ ZARQĀLĪ UNIVERSAL ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD MADE FOR NAWĀB IFTIKHĀR KHĀN, 1091 AH (AD 1680-1681)

Diameter 555 mm

Jaipur, Jai Singh’s Observatory

CCA 80; Répertoire 39

Figure A091.1 – Front of the astrolabe (photo by S. R. Sarma)

This monumental *zarqālī* universal astrolabe represents the culmination of Diyā’ al-Dīn’s craft. The inscription on the back records that it was produced at the behest of a high Mughal dignitary Nawāb Iftikhār Khān. It is a very large instrument, made of a single sheet of brass, and measures 555 mm in diameter and 643 in height. It is the last dated extant piece fashioned by Ḍiyā’ al-Dīn.

Within half a century of its manufacture, it was acquired by Sawai Jai Singh of Jaipur (1688-1742). Realizing of the importance of this universal astrolabe, he caused the composition of a Sanskrit manual entitled *Sarvadeśīya-jarakālī-yantra* on the construction and use of this instrument. At his orders a Sanskrit / Rajasthani name in Devanagari script was engraved at the back of the crown of the astrolabe thus: *yantra jarakālī sarvadeśī* (*Zarqālī* universal instrument) (see Figure A091.8). The first letters of the Sanskrit names of the zodiacal signs were engraved at appropriate places on both sides of the ecliptic. At several star positions Sanskrit names were added next to the original Arabic names; some new star positions were also marked and their Sanskrit names were inscribed. A detailed account of Jai Singh’s engagement with this astrolabe will be given in the last part of this entry.

In modern times, A. ff. Garrett was the first to notice this instrument at the beginning of the twentieth century when he renovated the Jaipur Observatory at the instance of the Maharaja of Jaipur; his remarks will be reproduced at the end of this description. Then, in 1918, G. R. Kaye devoted an exclusive chapter to this astrolabe in his celebrated work *The Astronomical Observatories of Jai Singh*.[436]

COMPONENTS

Main plate with *kursī* (d. 555, h. 643), shackle and ring, cross-bars, alidade with a sighting tube and pin. The wedge is missing; the ensemble is held together by a wire.[437]

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436 Kaye 1918, Chapter IV, pp. 27-30, 118, figs. 21-22. See also Gunther 1932, no. 80, pp. 212-213; Savage-Smith 1985, p. 45; Sarma 1996b.

437 Kaye 1918, p. 27 mentions a rough value of the diameter as ‘two feet’; others repeat it.

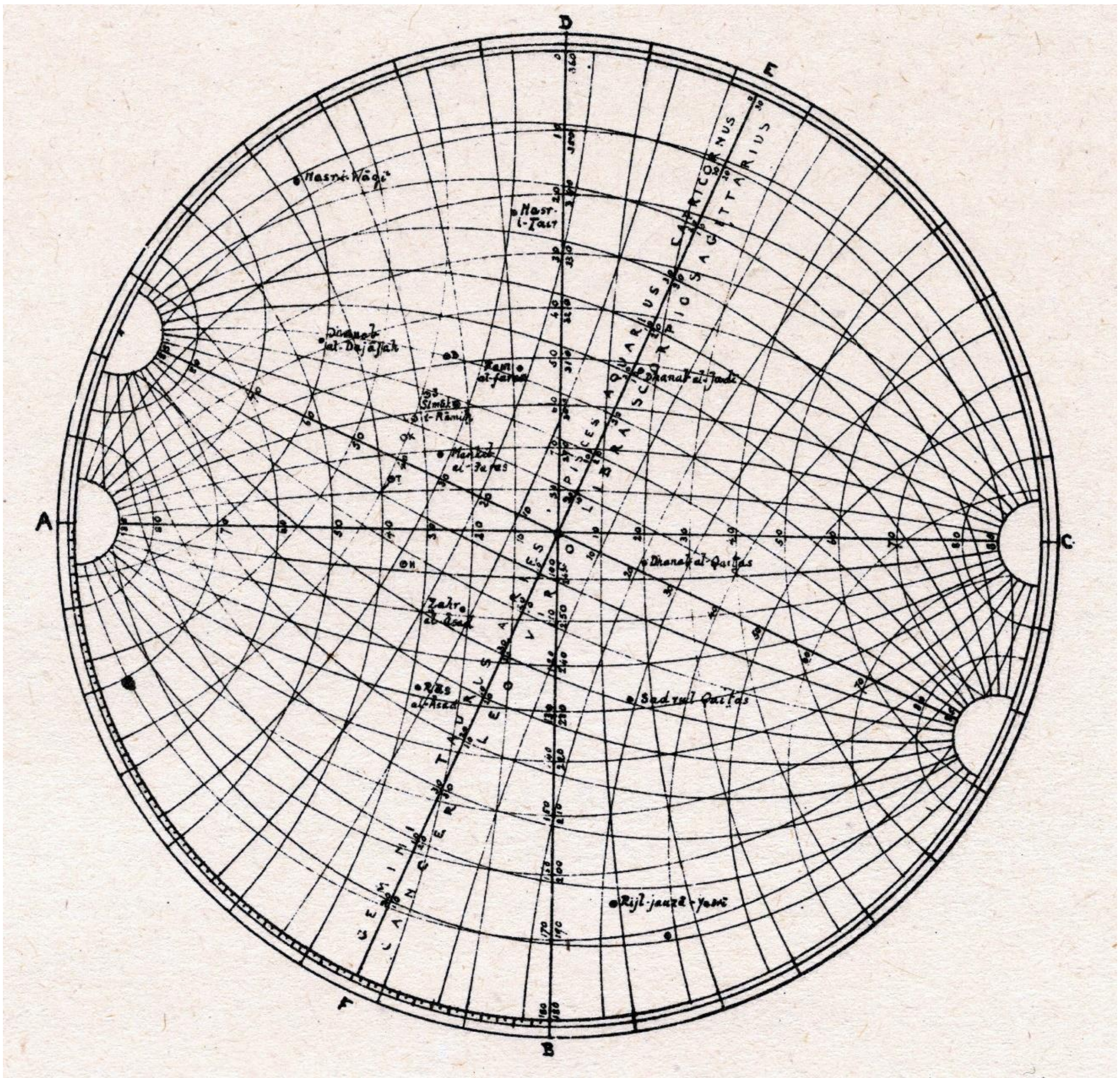

Figure A091.2 – Front of the astrolabe (diagram from Kaye 1918, fig. 21)

FRONT

The *kursī* and the plate are formed from a single sheet of brass. The profiles of the *kursī*, as in many other astrolabes by Ḍiyā’ al-Dīn, consist of a pair of ogees at the base and at the top, interspersed with a lobe in the middle. The finial is trifoliate, to which is attached a small shackle with ornate bases. The shackle and the ring that passes through it have diamond cross-sections. The *kursī* is solid and bears simple ornamentation. On both sides decorative lines run parallel to the profiles, and a pair of tulip-like flowers adorns the surface.

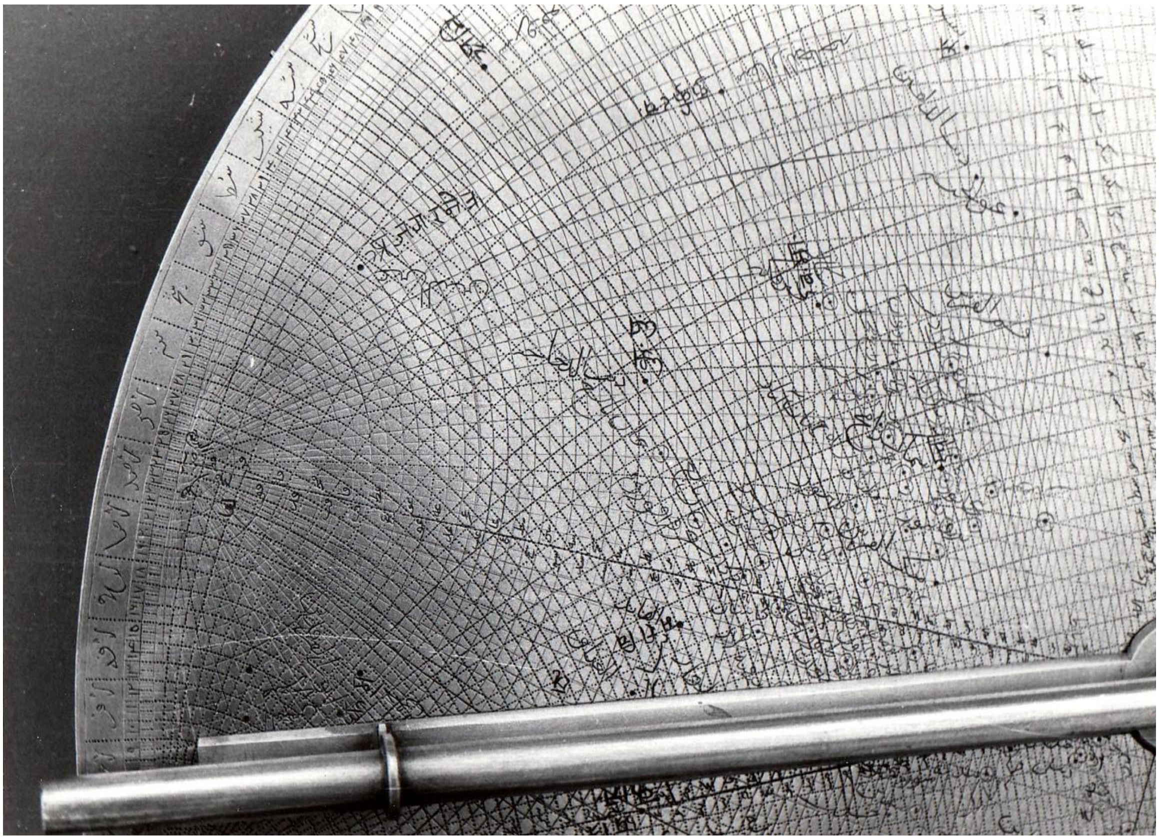
Figure A091.3 – Front of the astrolabe, detail of the upper left quadrant (photo by S. R. Sarma)

The *Zarqālī* projection, with the vernal / autumnal equinox as the centre and the solstitial colure as the plane of horizontal projection, is engraved on the obverse side of the instrument.[438] Here the outer rim is graduated for every three degrees and numbered in *abjad* notation in a clockwise direction, starting at the top. It appears that the east point is placed at top on this astrolabe — instead of the south point as in common astrolabes — so that it is north on the left and south on the right.[439]

438 Kaye 1918, p. 27, states that the ‘characteristic part of the instrument is engraved on the reverse.’ Because Jai Singh caused the Sanskrit name of the instrument engraved on the back of the *kursī,* Kaye appears to consider this side to be the front and the other side which carries the *Zarqālī* projection as the ‘reverse’. But there cannot be any doubt that the side where the Sanskrit name of the instrument was inscribed is the back of the astrolabe, for here are the altitude scales, shadow scales, the trigonometric quadrant and the various astrological tables. These are elements which are always on the back of the astrolabe.

439 The Sanskrit text states this explicitly: *yantre sanmukhe kṛte sva-dakṣiṇa-vibhāge dakṣiṇā dig jñeyā, vāma-bhāge saumyā dig jñeyā,* ‘when you hold the instrument in front of you, on your right is the southern direction and on your left the northern direction.’ See Appendix B4.

The next concentric ring is graduated for every degree and numbered in common Arabic/Persian numerals, separately for each quadrant from 1 to 90, also in a clockwise direction, starting at the top. Next there are divisions for every one-sixth of a degree.

Inside these degree scales are drawn two sets of coordinates, the equatorial and the ecliptical. The vertical diameter of the plate (extending from the east point at the top to the west point at the bottom) is the celestial equator. It is graduated for every three degrees and numbered, on the northern side from 1 to 180 running from the top to the bottom, and on the southern side from 181 to 360 in the reverse direction. Circles parallel to the equator are the circles of declination; these are drawn for every degree and numbered, from the centre to the poles, along the line which is perpendicular to the equator. Circles perpendicular to the equator and converging at its two poles are the circles of right ascension; these are drawn for every three degrees and numbered along the line of equator.

The ecliptic is also drawn as a straight line which passes through the centre of the plate and is inclined to the equator at an angle equal to the obliquity of 23;30°. It is marked with the zodiacal signs from Capricorn to Gemini in the north and from Cancer to Sagittarius in the south so that Aries and Pisces lie at the centre. Each sign is divided for every three degrees. Circles parallel to the ecliptic are the circles of latitude; these are drawn for every degree and numbered, from the centre to the poles, along the line which is perpendicular to the ecliptic. Circles which are perpendicular to the ecliptic and which pass through its two poles are the circles of latitude. These are drawn for every three degrees and numbered along the ecliptic.

Dotted lines are used for the equatorial system and simple lines for the ecliptic system so that these two can be clearly distinguished.

Against these two sets of coordinates, several star positions are marked with dots enclosed in circles and labelled. In some cases, Sanskrit names are added next to the Arabic names at the behest of Sawai Jai Singh. He also caused some more star positions marked with their Sanskrit names. At places, the plate is so cluttered with these names that it is difficult to decipher all the star names. Kaye recorded 14 names along with their equatorial and ecliptic coordinates and compared these values with those given by

Flamsteed.[440] Some more star names are added in the following table, but a complete list needs to be prepared.

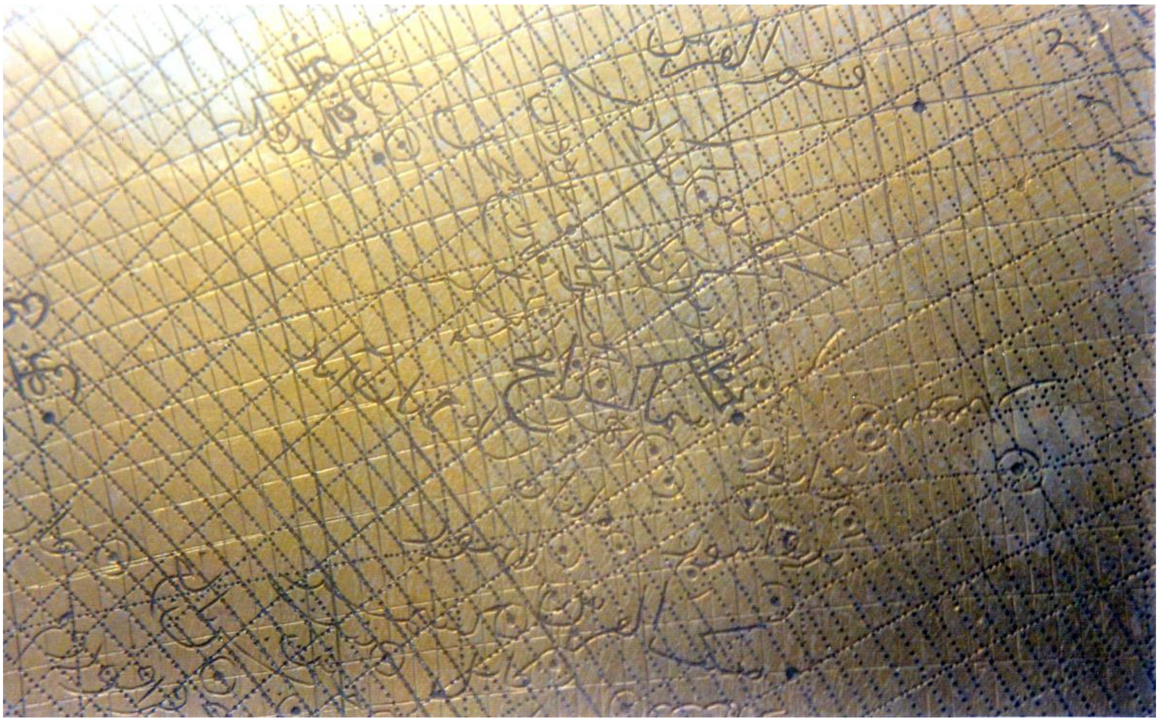

Figure A091.4 – Clutter of star pointers (photo by S. R. Sarma)

	Star Name	Identification	Sanskrit Name
1	*Dhanab al-Qayṭus*	β Ceti	
2	*Fam al-Qayṭus*	γ Ceti	
3	*Ṣadr al-Qayṭus*	π Ceti	
4	*Rās al-Ghūl*	β Persei	
5	*Mirfaq al-Thurayyā*	α Persei	
6	*ᶜAyn al-Thawr*	α Tauri	
7	*ᶜAyyūq*	α Aurigae	*Bra[hma-hṛdaya]*
8	*Rijl al-Jawzā’ al-Yusrā*	β Orionis	

[440] Kaye 1918, p. 118.

	Star Name	Identification	Sanskrit Name
9	*Yad al-Jawzā’ al-Yusrā*	γ Orionis	*Mithuna-vāma-hasta*
10	*Yad al-Jawzā’ al-Yumnā*	α Orionis	*Mithu[na-dakṣaṇa-hasta]*
11	*Shi*ᶜ*rā Yamānī*	α Canis Majoris	*Lubaṃ [! Lubdhaka]*
12	*Rās al Taw’am al-Muqaddam*	α Geminorum	
13	*Ras al Taw’am al-Mu’akkhar*	β Geminorum	*Punarvasu*
14	*Al-Qā’id*	β Ursae Majoris	*Pulaha*
15	*Rās al-Asad*	μ Leonis	*Siṃha-mastaka*
16	*Fard al-Shujā*ᶜ	α Hydrae	
17	*Ẓahr al-Asad*	δ Leonis	
18	*Al-*ᶜ*Anāq*	ζ Ursae Majoris	
19	?	η Ursae Majoris	*Marīci*
20	*Simāk Rāmiḥ*	α Bootis	*Svā[ti]*
21	*Rukbat al-Ḥawwā’ Yusrā*	β Orionis	*Sarpadhara kā vāgoṃḍā*[441]
22	ᶜ*Ayn al-Tinnīn*	γ Draconis	*Ajagara-netra*
23	*Nasr Wāqi*ᶜ	α Lyrae	*Abhi[jit]*
24	*Minqār al-Dajāja*	β Cygni	*Kurkuṭa-caṃ[cu]*
25	*Dhanab al-Dulfīn*	ε Delphini	
26	*Dhanab al-Dajāja*	α Cygni	*Ku[kkuṭa]-pu[ccha]*
27	*Fam al-Faras*	ε Pegasi	

441 The Arabic name means ‘the left knee of the serpent charmer’. The Sanskrit/Hindi rendering has *vāgoṃḍā* for ‘knee’ which makes no sense.

	Star Name	Identification	Sanskrit Name
28	*Dhanab al-Jadī*	δ Capricorni	
29	*Mankib al-Faras*	β Pegasi	

GEOGRAPHICAL GAZETTEER

This celestial map is also made to serve geographical purposes. Treating the celestial equator and the polar axis as the zero latitude and zero longitude respectively, a number of town names were inscribed at appropriate distances. These include Ḥalab, Ṭūs, Kābul, Shāhjahānābād, Lāhūr, Khān Bāligh, Bīs Bāligh, Multān and Kashmīr. Kaye shows that longitudes were reckoned from Baghdad.[442]

Climates

A little inside the rim of the north-western quadrant, the seven climates of antiquity are marked in their Persian form: *iqlīm awwal, iqlīm dūyam, iqlīm siwum, iqlīm chahārum, iqlīm panjum, iqlīm shashum, iqlīm haftum.* There are some labels before and after the seven climates, but these could not be deciphered.

BACK

On the back there are many scales and tables arranged in some twenty-six annular rings on the rim. Reading from the outer circumference to the centre, the annuli contain the following scales and tables.

1. The rim of the two upper quadrants carries altitude scales, labelled in *abjad* for every 3°, starting from the two ends of the horizontal diameter and reaching the upper end of the vertical diameter. The rim of the two lower quadrants carries shadow scales or cotangent scales, on the left for a gnomon of 12 digits followed by the label *ẓill aṣābiᶜ mabsūṭ* (umbra recta in digits) and on the right for a gnomon of 7 feet followed by the label *ẓill aqdām mabsūṭ* (umbra recta in feet).
2. Annulus graduated for 1° and labelled in common Arabic/Persian numerals.

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442 Kaye 1918, p. 29.

Figure A091.5 – Back of the astrolabe (photo by S. R. Sarma)

3. Each degree in the above row divided into 30′ and then into 10′.

4. Names of the twelve signs of the zodiac, starting from the south point and proceeding clockwise.

5. Each sign divided in 3° and numbered in abjad as 3, 6, 9, … 30.

6. Each sign divided in 1° and numbered from 1 to 30 in common Arabic/Persian numerals.

7. Each degree in the above row divided into 30′ and then into 10′.

8. Names of the 28 lunar mansions

9-19. Astrological tables, neatly separated from each other by a narrow blank annulus.

9-10. Duodenaries: 12 planets are assigned to each sign (the full table is reproduced in Kaye 1918, p. 125).

11-12. Novenaries: 9 planets are allotted to each sign (see Kaye 1918, p. 124, for the full table).

13-14. Limits or Terms of the signs. The five planets domiciled in each sign, their individual and cumulative strengths are given.

15-16. Septenaries: Each sign is given 7 planets (the full table is reproduced in Kaye 1918, p. 124).

17-18. Decans and their regents.

19. Looks like decans, but is different. Aries is assigned Mars, Sun and Jupiter.

20. Shadow scales once again, on the left for a gnomon of 12 digits and on the right for a gnomon of 7 feet; each unit divided in 10.

21-23. Calendar scale, concentric, separated from the scales above by a broad blank annulus.

21. Civil days of the months

22. Groups of 5 days, numbered in *abjad* separately for each month.

23. Names of the Rūmī (Syrian-Macedonian) months: *Kānūn al-Thānī* (January), *Shubāṭ* (February), *Ādhār* (March), *Nīsān* (April), *Ayyār* (May), *Ḥuzayrān* (June), *Tammūz* (July), *Āb* (August), *Aylūl* (September), *Tishrīn al-Awwal* (October), *Tishrīn al-Thānī* (November), *Kānūn al-Awwal* (December). Here the first point of Aries is placed at 10 *Ādhār* (March). According to Kaye, it is the correct value for the year 1680 when the instrument was made.

24. Long signature of the astrolabe maker (see below), separated from the rest by a blank ring on either side.

25. Groups of 5° labelled in abjad, starting from the east point, proceeding clockwise, 5, 10, … 90; 5, 10, … 90; 180, 175 … 95; 90, 85 … 5.

26. Single degrees.

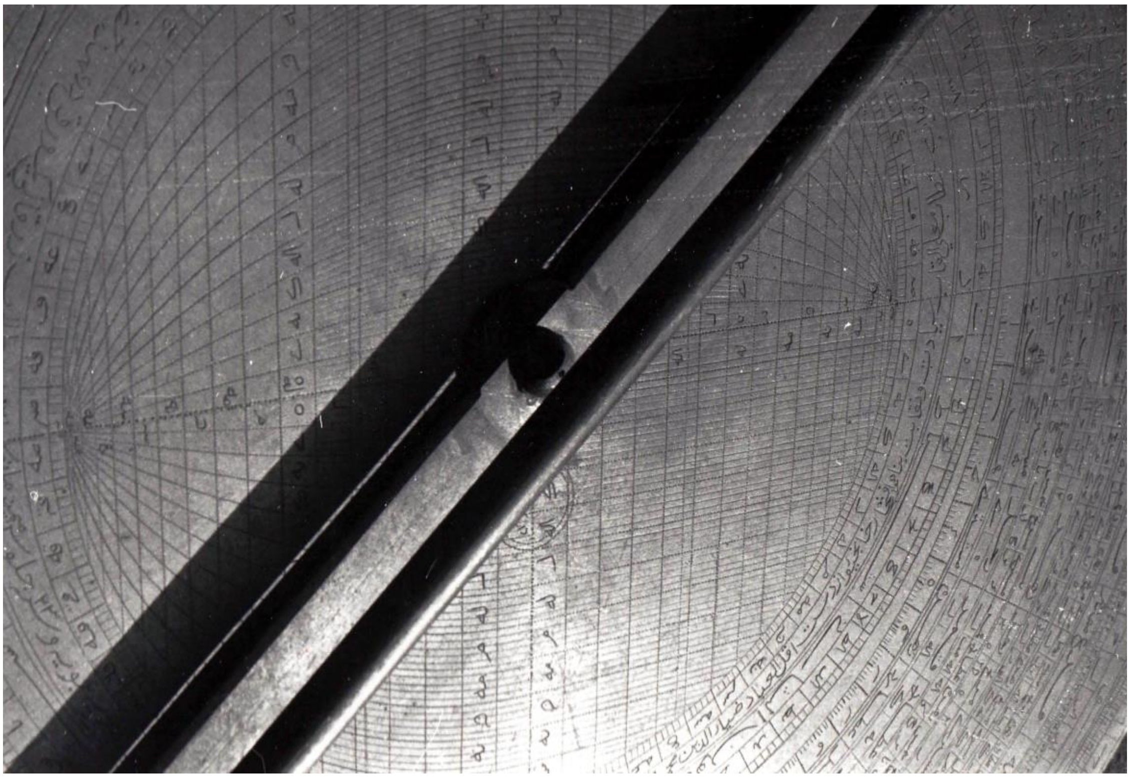

Figure A091.6 – Central part of the back (photo courtesy A. J. Turner)

The circle inside these annular rings is divided into four quadrants by the vertical and horizontal diameters. On the lower left is engraved a trigonometric quadrant. The vertical axis is divided into 60 parts and numbered in 5s in *abjad* from the centre up to the arc. From each point of division horizontal lines are drawn up to the arc; every fifth of these lines is dotted. The horizontal axis is also divided into 60 parts and numbered in 5s (as 5, 15, 25 …) and from every fifth point dotted vertical lines are drawn up to the arc.

The other three quadrants contain orthogonal projections of the great circles inclined to the meridian. The upper radius is divided into 60 equal parts and through each point of division, circles are drawn so that they pass through the two points at the extremities of the horizontal diameter of the circle inside the annual rings. Every fifth of these circles is highlighted with dots. To reduce the clutter, in some parts only the fifth circles are shown. These circles are also numbered in 5s in all the three quadrants.

The Circle of the Moon

The ‘Circle of the Moon’ is considered to be a special invention of al-Zarqalluh for graphically obtaining the earth-moon distance and then for determining the lunar parallax. He prescribes that the ‘centre is to coincide with the thirteenth division below

the centre of the *ṣafīḥa* and its radius is to be equal to six of these divisions. A concentric circle, with a smaller radius, is also inscribed and the ring between the two circles is divided into twenty-four equal parts.’[443] On my first visit to Jaipur, I missed this lunar circle. Therefore, I wrote in my earlier study of this astrolabe that there was no circle engraved nor was it mentioned in the Sanskrit manual on the *Zarqālī* astrolabe.[444] There is indeed a circle. But it is placed slightly differently, with its centre on the 24th parallel. There is a smaller concentric circle inside, but the ring is not divided into 24 parts.

Alidade/ Cross-bars

Originally the instrument must have been equipped with an alidade at the back for taking the altitudes, and a regula with a sliding transversal cursor in the front for reading the coordinates of any point in either the equatorial system or in the ecliptic system. These were missing in 1902 when the instrument was first noticed by Garrett.[445] Subsequently, sometime before 1918, cross-bars consisting of four arms at right angles and an alidade with a sighting tube were added to the instrument; neither is graduated.[446] The cross-bars could not have functioned in the same manner as the regula with sliding cursor. At a later point, the cross-bars were wrongly mounted on the back and the alidade on the front and the whole ensemble was tightly fixed with a wire. Therefore, in my photos, the alidade with sighting tube appears in the front and the cross-bars on the back.

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443 Puig 1989, pp. 295-296.

444 Sarma 1996b, p. 726.

445 Thus Garrett & Guleri 1902, p. 60, write: ‘There is a round hole in the centre of the disk which probably indicates the former existence of some kind of sighting bar for taking altitudes, but if so, this has now been lost’.

446 Kaye 1918, p. 27, speaks of the cross-bar but not of the alidade with the sighting tube. But the latter also must have existed then, for both are of the same workmanship.

Figure A091.7 – Ḍiyā’ al-Dīn’s name in the inscription (photo by S. R. Sarma)

INSCRIPTION

A long inscription is engraved along the entire circumference of the astrolabe in the twenty-fourth annulus on the back. The Persian text is reproduced in the Répertoire thus:

این اسطرلاب زرقالی یك ورقی در عهد حضرت محی الدین
محمد اورنك زیب بهادر عالم كیر بادشاه غازی ساخته شد در
بلده دار الخلافة حضرت شاه جهان آباد بفرمایش نواب مستطاب
معلی القاب سیادت و نقابت پناه نواب افتخار خانجیور از دست
اقل العباد ضیاء الدین محمد ابن ملا قایم محمد ابن حافظ عسی
(كذا) ابن شیخ الله داد همایونی اسطرلابی لاهوری فی سنة
۱۰۹۱ هجریة نبویة و سنة ۲۳ جلوس میمنت مانوس

*ayn **asṭurlāb zarqālī** yak-waraqī dar ahad ḥaḍrat **muhyī al-din muḥammad awrangjayb** bahādar ᶜālamgīr bādshāh ghāzī sākhteh shud dar bilād dār al-khilāfat ḥaḍrat shāh-jahān-ābād bi-farmāyish nawāb musaṭṭāb muᶜalī alqāb siyādat wa naqābat panāh **nawāb iftikhār khān**-jī’ū az dast aqall al-ᶜibād **ḍiyā al-dīn muḥammad** ibn mullā qā’im muḥammad ibn ḥāfiẓ ᶜīsā (kazhā) ibn shaykh allāhdād humāyānī asṭurlābī lahūrī fī sanah 1091 hijariyah nabūyah wa sanah 23 julūs maymant mānūs.*

‘This *zarqālī* astrolabe with a single plate (*yak-waraqī*)
in the reign (*dar ahad*) of His Majesty (*ḥaḍrat*) Muhyī al-Din Muḥammad Awrangjayb Bahādur ᶜĀlamgīr Bādshāh Ghāzī
was constructed (*sākhteh shud*) in the city, the seat of the Caliphate (*dār al-khilāfat*), the exalted (*ḥaḍrat*) Shāhjahānābad,

on the order of this excellent Nawāb, an illustrious and publicly esteemed sovereign and learned scholar (*bi-farmāyish nawāb musatṭāb muᶜalī alqāb siyādat wa naqābat panāh*), **Nawāb Iftikhār Khān**-Jī’ū[447]
with [his own] hand (*az dast*) [by] of the least of the servants [of God] (*aqall al-ᶜibād*), **Ḍiyā’ al-Dīn Muḥammad**, son of Mullā Qā’im Muḥammad, son of Ḥāfiz ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn (*asṭurlābī Humāyūnī*)
in the year 1091 of the Hijra of the Prophet and in the 23rd year of enthronement of His Dignified Prosperity (*maymant mānūs*).’[448]

Nawab Iftikhār Khān, the dedicatee of the astrolabe, was a high dignitary at the Mughal court.[449] It is interesting that the inscription expressly mentions that the astrolabe was made in Shāhjahānābad, i.e., Delhi. Since Ḍiyā’ al-Dīn and other members of his family were from Lahore, it is assumed that they had a workshop at Lahore where their astrolabes and globes were manufactured. However, there are absolutely no records to provide any information on this workshop, about the number of persons employed there or about the equipment used there. As mentioned already, all our information stems only from the extant instruments. Therefore, it is difficult to say

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447 In his mail of 11 March 2016, Prof. Irfan Habib explains that ‘Khān Jī’ū was a proper expression in 17th-century Indo-Persian; it is attested in the *Zakhīratu’l Khawānīn* which was completed in1651. *Jī’ū* corresponds to old Hindi *Jīv* and present *jī* (as in Gandhiji).’

448 This translation is based on the French rendering in the Répertoire. Mubashir Ul-Haq Abbasi and Dr Owen Cornwall helped in drafting the English version.

449 Cf. Beale 1894, p. 175: ‘**Iftikhar Khan,** title of Sulṭān Husain, the eldest son Mir ‘Abdūl Hādī, entitled Asālat Khān Mīr Bakhshī, who died at Balkh in the 20th year of the emperor Shāh Jahān A.D. 1647, A.H. 1057. In the first year of ‘Alamgir, Sulṭān Husain was honoured with the title of Iftikhār Khān. Sometime before his death he was appointed Fauzdār of Jaunpūr, where he died in A.D. 1681, A.H. 1092.’
Prof. Irfan Habib has kindly sent this note on Iftikhār Khān on 19 March 2016: ‘This chap was Governor of Ajmer when the Rathor rebellion broke out in 1678. There are many references to him in the unpublished *Waqa‘i* (Official Reports) from Ajmer at the time (unique copy in Asafiya Library, Hyderabad, and transcript at Aligarh). The Ma’asiru’l Umarā’s entry on him is mainly derived from Sāqī Musta‘idd Khān’s *Ma’āṣ-i ‘Ālamgīrī*. The latter work tells us that in A.H. 1090/22 RY/ AD 1679, on removal from the governorship of Ajmer (Bib. Ind. ed. pp. 173-74), Iftikhār Khān was asked to accompany Aurangzeb’s son Akbar to Lahore (p. 175). When the astrolabe was made in AH 1091/23 RY/AD 1680, he was apparently holding the post of *Faujdār* of Jaunpur. He died, while at Jaunpur in AH 1092/24 RY/AD 1681 (p. 209).’

whether Ḍiyā al-Dīn fabricated just this one astrolabe in Delhi or whether the entire workshop of the family was moved to Delhi about 1680.[450]

PROVENANCE

As mentioned above, Sawai Jai Singh acquired this astrolabe in the first quarter of the eighteenth century, together with other Lahore astrolabes like Ḍiyā’ al-Dīn’s beautiful astrolabe of 1656 (A072) and the splendid zoomorphic astrolabe which can be attributed to Muḥammad Muqīm (A051). First of all, he caused Sanskrit names of stars added next to the Arabic names so that the Hindu astronomers at his court could make use of this astrolabe. He also caused the Sanskrit name of the instrument engraved at the back of the *kursī.*

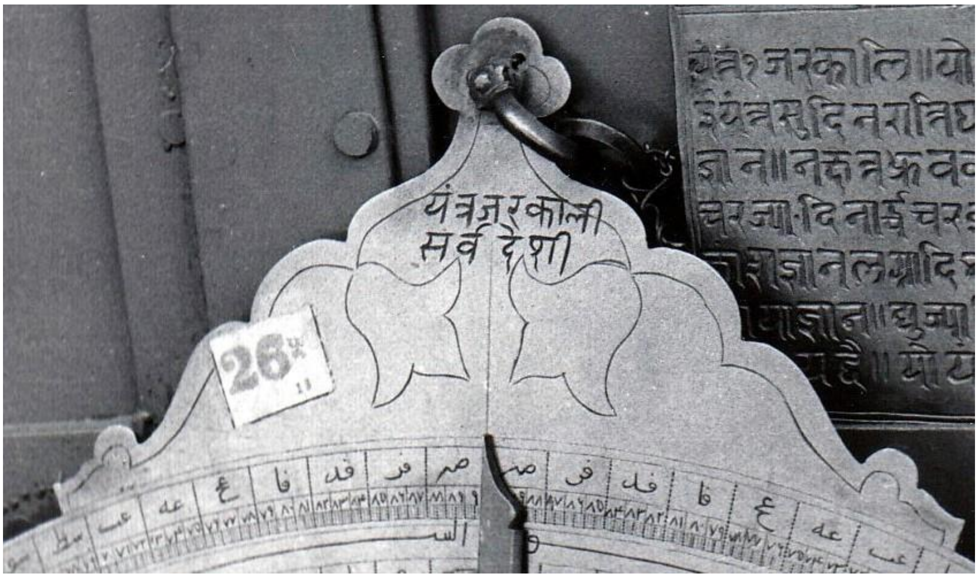

Figure A091.8 – Sanskrit name on the back of the *kursī* (photo by S. R. Sarma)

It appears that both Jai Singh and his son Madho Singh wished to set up a kind of private museum of astronomical instruments. For this purpose, copper plaques were added to many portable instruments mentioning the name and functions of the instruments.

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450 In the latter case, the astrolabes by his cousins Ḥāmid and Jamāl al-Dīn which bear dates after 1680 (such as A113, A114, A115, A001, A123, A124) may also have been made in Delhi.

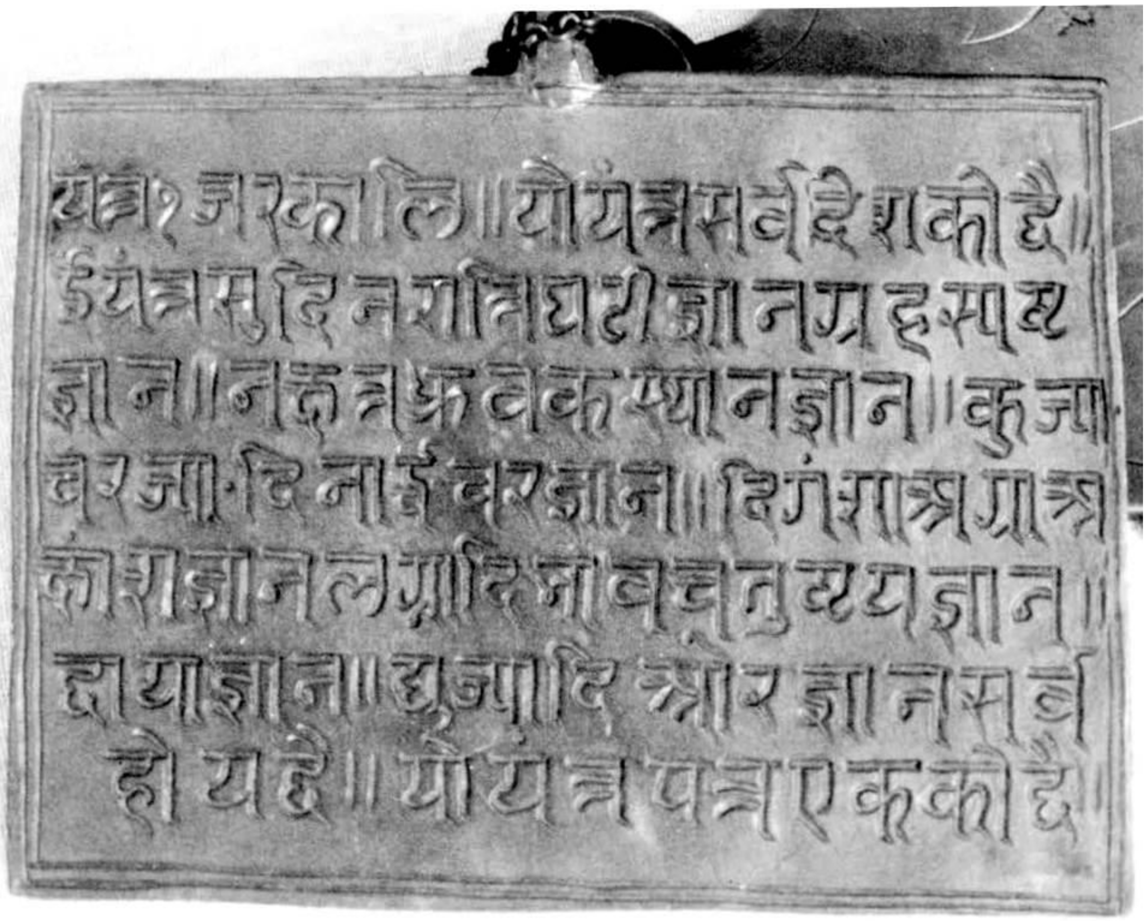

Figure A091.9 – The copper plaque (photo by S. R. Sarma)

The most impressive of such plaques is the one attached to the *Zarqālī* astrolabe on which the functions of this universal instrument were enumerated in Rajasthani dialect. The copper plaque, measuring 150 X 110 mm, reads as follows:

> One instrument [called] *Zarqālī.* This instrument is for all latitudes. This instrument provides the knowledge of [time in] *ghaṭīs* in the day and at night; knowledge of the true [longitudes of the] planets (*graha spaṣṭa jñāna*); knowledge of the polar longitudes of the fixed stars (*nakṣatra dhruvaka*); knowledge of the earth-sine (*ku-jyā*); sine of the ascensional difference (*cara-jyā*); half duration of daylight (*dinārdha*); ascensional difference (*cara*); knowledge of the azimuth (*digaṃśa*), amplitude (*agrā*) and terrestrial latitude (*akṣāṃśa*); knowledge of the four points on the ecliptic beginning with the ascendant (*lagna*); knowledge of the gnomon shadow (*chāyā*); knowledge of the day sine (*dyu-jyā*), and all other kinds of knowledge. This instrument consists of a single plate.

More important still is that Jai Singh caused the composition of a Sanskrit manual entitled *Sarvadeśīya-jarakālī-yantra* on the construction and use of this instrument. Extracts from this text will be reproduced along with translation in Appendix B4. There are forty sections in this work. The first section explains the construction of the front side of the astrolabe, while the second lays down how to prepare the reverse side. These two sections are designated jointly as *paraibhāṣa*, ‘definition.’ The remaining part is called *gaṇita-prakāra*, ‘method of computations’ and deals with the solving of various problems, such as finding the true longitude of the sun from the declination by three different methods; the converse of the problem, viz. finding the declination when the solar longitude is known, also by three different methods; finding the current ascendant and from it determining the same for any location or for another year, and so on.

In modern times, Lieutt. A. ff. Garrett of the Royal Engineers was the first to notice this instrument at the beginning of the twentieth century when he renovated the Jaipur Observatory at the instance of the Maharaja of Jaipur. In *The Jaipur Observatory and its Builder* which he wrote with Chandradhar Guleri, he states:

> There is also another […] instrument consisting of a brass disc about two feet in diameter on which is engraved a stereographic projection of the celestial sphere on the plane of the solstitial colure. Parallels of declination and latitude are drawn for every degree, and meridians and corresponding great circles through the pole of the ecliptic for every three degrees. The places of a number of stars are indicated by dots with the names written alongside. There is a graduated circle round the circumference divided into spaces of 10′, and the graduations are remarkably accurate for hand work. There is a round hole in the centre of the disc which probably indicates the former existence of some kind of sighting bar for taking altitudes, but if so, this has now been lost. This instrument was probably used as a star atlas, and also for the ready conversion of latitude and longitude into declination and right ascension and *vice versa*. Both sets of co-ordinates being engraved on

> the disc, one could be converted into the other by mere inspection, with an error of possibly a quarter of a degree.[451]

For his assistant who was barely nineteen at that time, Garrett is all praise in his preface:

> I have to express my thanks to Pundit Chandradhar Guleri, gold medallist of the Maharaja's College, Jaipur, for the great pains he has taken and the ability he has shown in translating Jai Singh's old astronomical works from Sanskrit into English. He has also helped in supervising the repairs to the observatory, and adjusting and testing the instruments.[452]

Chandradhar Sharma Guleri (1882-1922) graduated from Allahabad University, became the head of the department of Sanskrit in Mayo Collegea at Ajmer and was appointed in 1922 to the Manindra Chandra Nandi Chair in Ancient Indian History at Banaras Hindu University. But he is more renowned as one of the founders of the modern Hindi literature. In a book entitled *Śrī Candradhar Śarmā Gulerī: Vyaktitva aur Kṛtitva,* New Delhi 1983, by Pīyūsh Guleri, there is a rare photo showing Garrett and Guleri with the *Zarqālī* astrolabe, which is reproduced below.

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[451] Garrett & Guleri 1902, p. 60.

[452] Garrett & Guleri 1902, pp. 50-60, contains translations of extracts from Jai Singh's Sanskrit work on the astrolabe with the title *Yantrarāja-kārikā.* These translations must have been made by Guleri.

Figure A091.10 – Garrett and Guleri with the *Zarqālī* astrolabe

Guleri is on the right in the upper row, holding the *Zarqālī* astrolabe in front of him; Garrett must be the person sitting next to him in the middle of the row. The man in front of Garrett is holding a small-scale brass model of the *Cakra-yantra.*

A092⊙ ASTROLABE BY ḌIYĀ’ AL-DĪN MUḤAMMAD, NOT DATED

Diameter 282

London, Nasser D. Khalili Collection of Islamic Art of Islamic Art (#SC 283)

CCA 3651; Répertoire 40

Figure A092.1 – Back of the astrolabe (photo by S. R. Sarma)

Of this astrolabe, there survives only the mater with an exquisitely crafted *kursī*. The limb, the inner surface of the mater and the back are almost completely engraved with appropriate numbers, tables and labels. On the back, the rim on the lower half is not engraved with the cotangent scales. In the upper right quadrant, no sigmoid curves for the midday altitude of the sun were drawn. Moreover, the central hole through which the pin passes and the hole at the top of the *kursī* through which the shackle passes are very small and not large enough for their designated function. Inside the limb on the front, no peg has been attached to keep the latitude plates in position.

The mater is heavily damaged: there are large dents at the back and cracks around the central hole. The front side is worn off and covered with patina and grime. Probably the astrolabe maker first prepared the mater and engraved it almost completely on both sides; but before he could insert the peg on the front and enlarge the holes, there happened an accident in which the mater received the dents and cracks and therefore it was abandoned at this point. In such a case, a prudent metal worker would recycle the damaged piece and not leave it in the damaged condition. It is difficult to ascertain what actually happened.

It is however obvious that this astrolabe was planned on a very ambitious scale. Had it been completed according to plan, this would have become the most magnificent astrolabe fashioned by Ḍiyā’ al-Dīn. Even the heavily damaged mater still looks splendid with its throne. It is one of the few Lahore astrolabe where the *abjad* numbers on the limb and on the back, and also several other labels on the back are carved in relief against a finely hatched background as is done in the Safavid astrolabes of Iran.

Components

Mater with *kursī* (d. 282, h. 379, t. 15).

Front

The *kursī* is very intricately carved, creating a bouquet of five large flowers and several long leaves, all framed inside the two profiles which are topped by a trifoliate finial. There is much decorative engraving on the surface on both sides.

The limb is divided in 5° and 1° and labelled in 5s from 5 to 360 in *abjad* numbers which stand out in relief against a hatched background. But these *abjad* numbers are much worn out and cannot be deciphered easily.

Figure A092.2 – Geographical Gazetteer, detail showing the upper right hand corner (upside down) where the gazetteer commences (photo by S. R. Sarma)

Geographical Gazetteer

The gazetteer of 93 localities is engraved in three concentric circles with the tops of the letters pointing towards the centre of the astrolabe. The localities are arranged according to the climates, as in A074 and A088. In all the three astrolabes, at the end of the gazetteer where the localities beyond the seventh climate are to be listed, a few Indian localities are also added as if the astrolabe maker is making amends for forgetting to inscribe them at the correct place!

Nevertheless, the style in which the place names, their longitudes and latitudes are presented is very impressive. Each item of this data is placed inside a small cartouche. Between every two cartouches in a row are engraved tiny flowers with four petals. The rows are arranged so that the cartouches do not rest one upon the other vertically, but in a staggered fashion. The headings mentioning the climates are engraved in elongated letters; these are hardly distinguishable from the decorative designs.

Table A092-1 Geographical Gazetteer

	Locality *asmā’al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*	
	Outer Circle			
[-I] *az khaṭṭ istiwā’ tā iqlīm awwal* (from the equator to the first climate)				
01	Ṣāhil Baḥr Awqiyānūs	11;0	0;0	
02	Jazīra Qanbala	21;0	3;0	Madagascar
03	ᶜAdan	76;0	11;0	
[I] *al-iqlīm al-awwal* (the first climate)				
04	Jubil	75;0	13;30	K Jubla
05	Bajja	10;0	14;0	
06	Dabīl	74;20	14;10	
07	Ṣanᶜā’ Dār al-Mulk Yaman	77;30	14;30	
08	Janad	75;30	14;30	in Yemen
09	Sawmnāt	107;0	17;0	Somnath
10	Zaytūn	154;0	17;15	
11	Pījāpūr	105;0	17;20	
12	Burhānpūr	103;0	20;30	
13	Dawlatābād	111;0	20;30	
[II] *al-iqlīm dūyam* (the second climate)				
14	Jadda	76;0	21;0	
15	Tā’if	77;30	21;20	
16	Makka Muᶜaẓẓam	77;10	21;40	
17	Madīnat Musharrafa	75;20	25;0	

	Locality *asmā’al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*
18	Kanbāyat	109;20	22;20
19	Khaybar	75;20	24;20
20	Hurmūz	92;0	25;0
21	Haḍrat Ajmīr	101;5	26;0
22	Kawāliyār	114;43	26;30
23	Lahknawtī	114;43	26;30
24	Qannawj	115;50	26;35
25	Jawnpūr	119;6	26;36
26	Akbarābād Dār al-Khilāfat	114;0	26;43
27	Kara wa Mānikpūr	118;10	26;49
28	Badāwan	119;19	27;32
[III] *al-iqlīm siwum* (the third climate)			
29	Kūlkanda	114;19	18;3
30	Kūl [wa] Jalālī	114;19	28;4
31	Fīrūzābād	106;30	28;10
32	Shāhjahānābād	113;35	28;39
33	Baran	114;--	28;43
34	Pānīpat	113;20	28;20
35	Shīrāz	88;0	29;36
36	Multān	107;35	29;40
37	Hānsī	112;25	29;45
38	Baṣra	84;0	30;0
39	Kirmān	91;30	30;5

	Locality *asmā’al-buldān*	L *al-ṭūl*	φ *al-ᶜarḍ*
	Middle Circle		
[III] *tatimma al-iqlīm siwum* (continuation of the third climate)			
40	Tānīsar	112;33	30;10
41	Iskandariyya	61;54	30;18
42	Miṣr	63;20	30;20
43	Kūfa	79;30	31;30
44	Bayt al-Maqdis Dār al-Saṭna (?)	66;30	31;50
45	Lāhūr	109;20	31;50
46	Yazd	89;0	32;0
47	Iṣfahān	87;40	32;25
48	Qandahār	107;40	33;0
49	Madā’in	72;0	33;0
50	Dimashq	70;0	33;15
51	Maymand	81;55	33;20
52	Baghdād	82;0	33;25
[IV] *al-iqlīm chahāram* (the fourth climate)			
53	Mawṣil	77;0	34;30
54	Tūn	92;30	34;30
55	Harāt	94;30	34;30
56	Kābul	104;40	34;30
57	Rayy	86;20	35;20
58	Kashmīr	108;0	35;0
59	Hamadān	83;0	35;10

	Locality *asmā’al-buldān*	L *al-ṭūl*	φ *al-ʿarḍ*
60	Ḥalab	72;10	35;50
61	Mashhad Maqdis	92;30	36;0
62	Sabzawār	91;30	36;5
63	Balkh	101;0	36;41
64	Ṭāliqān	85;45	36;10
65	Qazwīn	85;0	35;55
66	Badakhshān	104;24	37;10
67	Sarakhs	94;30	37;30
68	Tabrīz	82;0	38;0
69	Ardabīl	80;0	38;0
70	Nakhjawān	81;15	38;40
	Inner Circle		
[V] *al-iqlīm panjum* (the fifth climate)			
71	Samarqand	99;16	39;37
72	Bukhārā	97;30	39;50
73	Tubbat	110;0	40;0
74	Bardaʿa	83;0	40;30
75	Shamākhī	84;30	40;50
76	Khujand	85;35	41;15
77	Khutan	87;0	42;0
78	Kāshān	81;35	42;0
[VI] *al-iqlīm shashum* (the sixth climate)			
79	Kāshghar	106;30	44;0

	Locality *asmā’al-buldān*	L *al-ṭūl*	φ *al-ʿarḍ*	
80	Shalkh	84;30	44;0	
81	Pīsh Bāligh	81;0	44;50	
82	Qarāqūrūm	105;0	46;0	
83	Khān Bāligh	124;0	46;0	
84	Harla	67;20	46;30	correct Harqala
[VII] *al-iqlīm haftum* (the seventh climate)				
85	Araq	85;0	48;0	
86	Bulghār	90;0	49;30	
87	Aqchā Kirmān	62;0	50;0	
88	Qirqir	65;30	50;0	
[VII+] *al-iqlīm khāriz* (beyond the [seventh] climate)				
89	Jazā’ir Rūdjard	68;50	62;0	K Hebrides
90	Dhākā Bankālā[453]	130;0	27;0	
91	Ilāhābād	115;34	26;50	
92	Sūrat	110;50	20;15	
93	Patnah	120;45	29;40	

BACK

On the back, the rim of the two upper quadrants carries altitude scales which are divided in 5°, 1° and 0;20°and labelled in 5s as 5—90; 90—5. In addition, in the rim of the upper left quadrant, the groups of 5° are counted also in the reverse direction (i.e.,

[453] This and the next three are not situated beyond the seventh climate, but in the third. They are inserted here as addenda; the same is done in A074, A082, A088, A096 also.

from the south point to the east) in common Arabic/Persian numerals which are engraved just above the *abjad* numerals. The upper left quadrant contains a sine-cosine graph with 60 horizontal and 60 vertical parallels. These are counted along both the vertical and horizontal radii, from the centre to the arc, in groups of 5. As the rim of this quadrant constitutes the arc of the sine quadrant, it is convenient to have the divisions of the arc numbered in both directions.

The upper right quadrant is divided by 30 declination arcs, one for each decan or 10° of the solar longitude. The names of the corresponding zodiac signs are engraved in embossed letters along the two radii; the numerical values of the decans are engraved above the names of the zodiac signs. However, graphs of solar meridian altitudes at different latitudes are not plotted on this quadrant, as is done in other Lahore astrolabes.

Figure A092.3 – Back of the Astrolabe; the lower half (photo by S. R. Sarma)

In the lower half, just below the horizontal diameter, are engraved the shadow squares, on the left for a gnomon of 12 digits and 60 parts and on the right for a gnomon of 7 feet. The vertical and horizontal scales on both sides are divided appropriately and endowed with the following labels. The letters of these four labels are also embossed in relief.

Vertical scale on the left	*ẓill sullam aṣābi*ᶜ *wa sittaynī ma*ᶜ*kūs*
Horizontal scale on the left	*ẓill sullam aṣābi*ᶜ *wa sittaynī mustawī*

Horizontal scale on the right	*ẓill sullam ᶜaqdām mustawī*
Vertical scale of the right	*ẓill sullam ᶜaqdām maᶜkūs*

Table of Rising Times of the Signs at Latitudes from 20° to 40°

Inside the shadow squares, there is a table with its title engraved in relief: *zadwal sāᶜāt ṭulūᶜ burūj bi-ᶜarḍ baᶜḍī az bilād mulk al-Hind* (table of the times of rising of signs in the latitudes of some of the localities belonging to the country of India).[454]

Table A092-2 Rising Times of the Signs

Signs → **Latitudes**	**Aries Pisces** (h;m)	**Taurus Aquarius** (h;m)	**Gemini Capricorn** (h;m)	**Cancer Sagittarius** (h;m)	**Leo Scorpio** (h;m)	**Virgo Libra** (h;m)
20°	1;34	1;46	2;3	2;14	2;14	2;9
21°	1;34	1;45	2;3	2;15	2;14	2;10
22°	1;33	1;44	2;3	2;10	2;16	2;10
23°	1;32	1;44	2;2	2;10	2;16	2;9
24°	1;31	1;43	2;2	2;16	2;16	2;12
25°	1;30	1;42	2;2	2;16	2;17	2;13
26°	1;29	1;41	2;1	2;16	2;18	2;14
27°	1;28	1;40	2;1	2;17	2;19	2;15
28°	1;27	1;39	2;0	2;17	2;20	2;16
29°	1;26	1;38	2;0	2;17	2;21	2;18
30°	1;25	1;38	2;0	2;18	2;22	2;19
31°	1;25	1;37	1;39	2;18	2;23	2;20
32°	1;22	1;36	1;18	2;19	2;24	2;21
33°	1;21	1;35	1;18	2;19	2;25	2;22
34°	1;20	1;34	1;18	2;20	2;26	2;23

454 Cf. A072 where the table stops at 39°.

Signs → **Latitudes**	**Aries** **Pisces** (h;m)	**Taurus** **Aquarius** (h;m)	**Gemini** **Capricorn** (h;m)	**Cancer** **Sagittarius** (h;m)	**Leo** **Scorpio** (h;m)	**Virgo** **Libra** (h;m)
35°	1;19	1;33	1;18	2;20	2;27	2;24
36°	1;18	1;32	1;17	2;20	2;28	2;26
37°	1;16	1;31	1;17	2;21	2;29	2;27
38°	1;16	1;29	1;17	2;21	2;30	2;28
39°	1;14	1;28	1;16	2;22	2;31	2;30
40°	1;13	1;27	1;16	2;22	2;32	2;31

Between the table and the horizontal diameter is the astrolabe maker’s signature which is reproduced below.

Figure A092.4 – Astrological Tables, detail of Figure A036.3, showing the signs *al-Ḥamal* (Aries) and *al-Thawr* (Taurus) (row 1), the lunar mansions *Ṣaratān*, *Buṭayn*, *Thurayya*, *Debaran* and *Haq’ah* (row 2), planetary regents of the limits (row 3), their quantities of influence (row 4), regents of decans (row 5), the decans (row 6), names of planets with unidentified function (row 7) and decans (row 8).

The rim of the lower half is blank; no cotangent scale engraved here. But between the rim and the shadow squares there are 8 semi-circular rows containing the following data. The rows 1 and 2 as counted from the outside carry the names of the 12 zodiac signs and the names of 28 lunar mansions in relief.

Table of the Limits of the Signs

Thereafter, the rows 3 and 4, together with the row 1 containing the names of signs, constitute the table of the limits of the signs (*ḥudūd*). In row 3 are the names of the five planetary regents of each sign; these names are engraved here in full and not with the final consonants of their Arabic names as is usually done on astrolabes. In row 4, there are two registers; the upper register in *abjad* shows the quantity of influence exercised by the regent. The lower register in standard Arabic/Persian numerals shows the cumulative influence, i.e., the quantity of this influence of a particular regent plus the preceding quantities in this sign.

Because of the constraints of space, in the table below the signs are arranged in a vertical column. In the three rows related to each sign, the first row carries the names of the five planets, the second the individual limit assigned to each planet and the third the cumulative values in bold numerals.

Table A092-3

Aries	Jupiter	Venus	Mercury	Mars	Saturn
	6	6	8	5	5
	6	**12**	**20**	**25**	**30**
Taurus	Venus	Mercury	Saturn	Jupiter	Mars
	8	6	5	8	3
	8	**14**	**19**	**27**	**30**
Gemini	Mercury	Jupiter	Venus	Mars	Saturn
	6	6	5	7	6
	6	**12**	**17**	**24**	**30**
Cancer	Mars	Venus	Mercury	Jupiter	Saturn
	7	6	6	7	4
	7	**13**	**19**	**26**	**30**
Leo	Jupiter	Venus	Saturn	Mercury	Mars
	6	5	7	6	6
	6	**11**	**18**	**24**	**30**
Virgo	Mercury	Venus	Jupiter	Mars	Saturn
	7	10	4	7	2
	7	**17**	**21**	**28**	**30**

Libra	Saturn	Mercury	Jupiter	Venus	Mars
	6	8	7	7	2
	6	**14**	**21**	**28**	**30**
Scorpio	Mars	Venus	Mercury	Jupiter	Saturn
	7	4	8	5	6
	7	**11**	**19**	**24**	**30**
Sagittarius	Jupiter	Venus	Mercury	Saturn	Mars
	12	5	4	5	4
	12	**17**	**21**	**26**	**30**
Capricorn	Mercury	Jupiter	Venus	Saturn	Mars
	7	7	8	4	4
	7	**14**	**22**	**26**	**30**
Aquarius	Mercury	Venus	Jupiter	Mars	Saturn
	7	6	7	5	5
	7	**13**	**20**	**25**	**30**
Pisces	Venus	Jupiter	Mercury	Mars	Saturn
	12	4	3	9	2
	12	**16**	**19**	**28**	**30**

Table of Decans and their Regents

The next four rows are devoted to decans or faces. Rows 6 and 8 carry the numerical values of decans (10, 20, 30) while rows 5 and 7 are engraved with the names of the regents of the decans in relief against a hatched background. Here the astrolabe suffered much damage and it is difficult to read the names of the planetary regents. With great effort the names of the planets could be read in row 5 and establish that rows 5 and 6 constitute a table of decans (*wujūh*) as we know from other astrolabes.

Table A092-4 Decans and their Regents

Signs	**10°**	**20°**	**30°**
Aries	Mars	Sun	Venus
Taurus	Mercury	Moon	Saturn
Gemini	Jupiter	Mars	Sun
Cancer	Venus	Mercury	Moon
Leo	Saturn	Jupiter	Mars
Virgo	Sun	Venus	Mercury
Libra	Moon	Saturn	Jupiter

Scorpio	Mars	Sun	Venus
Sagittarius	Mercury	Moon	Saturn
Capricorn	Jupiter	Mars	Sun
Aquarius	Venus	Mercury	Moon
Pisces	Saturn	Jupiter	Mars

Row 7 also appears to contain the names of planets, but in a sequence different from that in row 5. Here the names of the planets are hardly legible. With difficulty, the data related to the first four signs are deciphered as shown in the following table.

Table A092-5

	10°	**20°**	**30°**
Aries	Mars	Sun	Jupiter
Taurus	Venus	Mercury	Saturn
Gemini	Mercury	Venus	Saturn
Cancer	Moon	Mars	Jupiter

This table is clearly different from the table of *wujūḥ;* it is also different from the variant called *ardjān.*[455] Its nature remains unknown.

INSCRIPTION

ᶜamal aqall al-ᶜibād ḍiyā’ al-dīn muḥammad ibn qā’im muḥammad ibn mullā ᶜīsā ibn shaykh allāhdād asṭurlābī humāyūnī lāhūrī.

‘The work of the least of the servants [of God], Ḍiyā’ al-Dīn Muḥammad, son of Qā’im Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.’

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455 On *ardjān,* see Khareghat 1950, pp. 19-20.

Provenance

Formerly of the collection of Mrs. L. Marjory Hopkins; collection of Nicholas Landau, Paris.

Bibliography

Sotheby’s, London, Catalogue, 7 May 1956, lot 114.

Maddison & Savage-Smith 1997, part I, no. 130, p. 226, 227.

A093⊙ ASTROLABE ATTRIBUTABLE TO ḌIYĀ’ AL-DĪN MUḤAMMAD

Date not available, after 1648

Diameter 526 mm

London, Nasser D. Khalili Collection of Islamic Art (#SCI 53)

Figure A093.1 – Front of the astrolabe. The Nasser D. Khalili Collection of Islamic Art, Accession No. SCI 53. Photo courtesy of the Khalili Family Trust © Nour Foundation

This large Indo-Persian astrolabe was thoroughly reworked with Sanskrit labels in 1701 at the instance of Nayanānanda of Delhi. In this process the inscription containing the name of the maker and the date of its manufacture got erased. But internal evidence shows that the astrolabe was made by Ḍiyā' al-Dīn Muḥammad, sometime after 1648 when Delhi was renamed Shāhjahānābād, and that it was created for no less an exalted personage than the Emperor Shāh Jahān himself. The Sanskrit labels will be described in E004.

COMPONENTS

Body with *kursī* (d. 526, h. 602, t. 14), ring, shackle, rete for 53 stars, 6 plates. Alidade, pin and horse are missing.

FRONT

The suspension apparatus of the astrolabe consists of a heavy ring and a heavy shackle, both with an octagonal cross section. The terminals of the shackle are simple and circular. Through these two terminals and the tip of the *kursī* passes a pin, attaching the shackle thus to the *kursī* and to the main body of the astrolabe. The *kursī* is rather small for the enormous size of the astrolabe. It is solid and filled with designs in the front and on the back inside a heavy rim that runs along the lobed profiles. In the front there is a simple floral design.

On the back of the *kursī* is engraved an image in low relief of a finely drawn falcon swooping down and tearing into a bird, while smaller birds, one each on either side, are scuttling away from the fearsome falcon. This is an unusual image; such an image does not occur in any of the Lahore astrolabes. It alludes to an event in the career of the Shāh Jahān. Around 1634 he sent a letter to the Sulṭān of Bijapur, Muḥammad ᶜĀdil Shāh, ordering him to see that *khuṭba* be read in Shāh Jahān's name in the Bijapur territory; otherwise he would pounce on the Sulṭān and tear him to pieces just as a falcon tears into a hoopoe.[456] Thus this unusual image, by referring to Shāh Jahān's efforts to subjugate the minor kingdom of the Deccan, clearly establishes that this large and

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[456] Fischel 2012, pp. 253-54: see also Sarma 2016 (forthcoming).

lavishly decorated astrolabe with many special features, which will be described below, was made for the Emperor Shāh Jahān himself.

Figure A093.2 – Falcon attacking Hoopoes on the Back of the *Kursī.*
The Nasser D. Khalili Collection of Islamic Art, Accession No. SCI 53.
Photo courtesy of the Khalili Family Trust © Nour Foundation

RETE

The rete, measuring 151 mm in diameter, is the most ornate part of the astrolabe. It is thicker in the middle and tapers towards the rim; the thickness at the centre is about 3 mm and that at the rim is 1.5 mm. It consists of a Capricorn ring and a much wider ecliptic ring. These two are held together by the equinoctial bar which has counter changes at its two intersections with the ecliptic ring. The vertical solstitial bar is shown partially. The space between the two rings and inside the ecliptic ring is filled with floral tracery of a creeper with abundant leaves and flowers. The creeper rises from the Capricorn ring at its north point, branches off to the right and left and fills the whole space between the two rings; another branch enters the ecliptic ring, fills the space inside and culminates in a large empty circle with small protuberances issuing from its outer circumference. On the stem of the creeper, a little above the north point, is a large knob with which to rotate the rete around the centre.

Figure A093.3 – Rete of the astrolabe (photo by S. R. Sarma)

The ecliptic ring carries four circular scales: (i) the innermost scale is divided into 28 lunar mansions and their names are written in outline against a hatched background; (ii) the next scale is divided into the 12 zodiac signs and their names are embossed in low relief; (iii) in the third scale, groups of 3° are labelled in *abjad* notation, separately for each sign as 3, 6, 9 … 30; and (iv) the outermost scale on the rim of the ecliptic circle is divided into single degrees. The boundary lines between the lunar mansions, those between the zodiac signs, the divisions of 3°, and divisions of 1° are marked by inlaid silver wire.

Figure A093.4 – Ecliptic ring on the rete (detail showng the signs Capricorn, Aquarius and Pisces)
The Nasser D. Khalili Collection of Islamic Art, Accession No. SCI 53
Photo courtesy of the Khalili Family Trust © Nour Foundation

The pointed tips of the leaves and other projections on them constitute 53 star pointers; 29 of these are inside the ecliptic, i.e., to the north of the ecliptic circle, and 24 outside the ecliptic, i.e. to the south of the ecliptic between the ecliptic and the Tropic of Capricorn. The star names are inlaid with silver on the leaves of the tracery.

Table A093-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus Janūbī*	β Ceti
2	*Baṭn al-Ḥūt*	β Andromedae
3	*Fam al-Qayṭus*	γ Ceti
4	*Ṣadr al-Qayṭus*	π Ceti
5	*Kaff al-Jadhmā’*	α Ceti
6	*Rās al-Ghūl*	β Persei
7	*Mirfaq al-Thurayyā*	α Persei
8	*Tālī Masāfat al-Nahr*	γ Eridani
9	*ᶜAyn al-Thawr*	α Tauri
10	*ᶜAyyūq*	α Aurigae
11	*Rijl al-Jawzā’ Yusrā*	β Orionis
12	*Yad al-Jawzā’ Yusrā*	γ Orionis
13	*Yad al-Jawzā’ Yumnā*	α Orionis
14	*Rijl Jawzā’ [Yumnā]*	κ Orionis
15	*Shiᶜrā Yamānī*	α Canis Majoris
16	*Shiᶜrā Shāmī*	α Canis Minoris
17	*Ṭarfat Safīna*	ρ Puppis
18	*Nathra Saḥābī*	ε Cancri
19	*Fard Shujāᶜ*	α Hydrae
20	*Rās al-Asad*	μ Leonis
21	*Qalb al-Asad*	α Leonis
22	*Ẓahr Dubb Akbar*	α Ursae Majoris
23	*Qā’idat al-Bāṭiya*	α Crateris
24	*Ẓahr al-Asad*	δ Leonis

	Star Name	Identification
25	*Al-Ṣarfa*	β Leonis
26	*Al-ᶜAnāq*	ζ Ursae Majoris
27	*Janāḥ al-Ghurāb*	γ Corvi
28	*Simāk al-Aᶜzal*	α Virginis
29	*Simāk Rāmiḥ*	α Bootis
30	*Kiffa J[anūbī]*	α Librae
31	*Kiffa Shamālī*	β Janūbī
32	*Nayyir Fakkā*	α Coronae Borealis
33	*ᶜUnuq al-Ḥayya*	α Serpentis
34	*Qalb al-ᶜAqrab*	α Scorpii
35	*Rukbat al-Ḥawwā’ al-Yusrā*	ζ Ophiuchi
36	*Rās al-Jāthī*	α Herculis
37	*Rās al-Ḥawwā’*	α Ophiuchi
38	*ᶜAyn al-Tinnīn*	γ Draconis
39	*Yad al-Ḥawwā’ al-Yumnā al-Muqaddam*	δ Ophiuchi
40	*Nasr Wāqiᶜ*	α Lyrae
41	*Minqār al-Dajāja*	β Cygni
42	*Nasr Ṭā’ir*	α Aquilae
43	*Dhanab al-Dulfīn*	ε Delphini
44	*Dhanab al-Dajāja*	α Cygni
45	*Fam al-Faras*	ε Pegasi
46	*Dhanab al-Jadī*	δ Capricorni
47	*Mankib Sākib al-Mā’*	α Aquarii

	Star Name	Identification
48	*Sāq Sākib al-Mā’ J[anūbī]*	δ Aquarii
49	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
50	*Mankib al-Faras*	β Pegasi
51	*Surrat al-Faras*	δ Pegasi = α Andomedae
52	*Janāḥ al-Faras*	γ Pegasi
53	*Dhāt al-Kursī*	β Cassipeiae

ZAWRAQĪ HORIZONS ON THE RETE

In this rete are incorporated two small *zawraqī* horizons which intersect each other on the equinoctial bar. The arc with the convex side to the north is the oblique horizon for latitude 29° (Delhi). The western and eastern halves of the arc carry the labels *ufq mujassam gharbī bi-ᶜarḍ 29,* ‘western solid horizon for latitude 29’ and *ufq mujassam sharqī bi-ᶜarḍ 29,* ‘eastern solid horizon for latitude 29’ respectively. The mast corresponding to this arc, i.e., the solstitial bar above the central hole, has the inscription *shaẓiya yatiru zawraq fawq al-ᶜard,* ‘pointer spanning the *zawraqī* horizons above the latitude’.

Figure A093.5 – The Oblique Horizons for the Latitudes of 29° and 32° on the Rete
The Nasser D. Khalili Collection of Islamic Art, Accession No. SCI 53

The second arc, with the convex side to the south is the oblique horizon for latitude 32° (Lahore). Two halves of this arc carry the labels *ufq mujassam gharbī bi-ᶜarḍ 32,* ‘western solid horizon for latitude 32’ and *ufq mujassam sharqī bi-ᶜarḍ 32,* ‘eastern solid horizon for latitude 32’. Its mast, i.e., the solstitial bar below the central hole, bears the label *shaẓiya yatiru zawraq taḥt al-ᶜard,* ‘pointer spanning the *zawraqī* horizons below the latitude’.

The equinoctial bar carries the label *mastarat tarbī’ gharbī,* ‘western perpendicular rule’ in the west and the label *mastarat tarbī’ sharqī,* ‘eastern perpendicular rule’ in the east.

All these inscriptions on the two arcs and on the solstitial and equinoctial bars are inlaid in silver. These *zawraqī* horizons have to be used with a special plate which will be described in the following section.

Plates

There are six plates in this astrolabe. The first five plates serve different latitudes between 0° and 45°. The obverse side of the sixth plate is engraved with the ecliptic

coordinates and the reverse side with the tablet of horizons. The plates have a uniform diameter of 501 mm, but with varying thickness. There is a notch at the north point in all the plates into which the peg affixed at the same place on the mater fits in and holds the plates in position.

Table A093-2 Plates

	φ	Longest Day
1a	*zawraqī plate* for 29° +32°	
1b	18°	13;9 hours
2a	0°	12 hours
2b	3°	12;11 hours
3a	27°	13;43 hours
3b	29°	13;52 hours
4a	37°	14;31 hours
4b	39	14;45 hours
5a	42°	14;0 hours! It should read 15;0
5b	45°	15;22 hours
6a	66;30° Tablet of ecliptic coordinates	
6b	Tablet of horizons	

The plate faces 1a, 2a, 6a and 6b contain special projections which will be described below. The rest of the plates are fashioned in the same style with altitude circles drawn for each 1° and azimuth circles for every 15° above the horizon and for every 3° below the horizon. Each sixth altitude circle is highlighted by a dotted line. The altitude circles are numbered serially from 1 to 90, from the horizon up to the zenith, both in the eastern and western halves, the series of numbers in these two parts forming a symmetrical pattern. The azimuth circles are also numbered in a symmetric form.

In the lower half, lines for equal and unequal hours are drawn between the tropics of Cancer and Capricorn and numbered.

Plate 6a for latitude 66;30°

The obverse side of the sixth plate contains a stereographic projection relative to the latitude of 66;30°, which is a complement of the total obliquity of 23;30°. Here the local horizon coincides with the ecliptic circle. The ecliptic circle is divided into the 12 signs of zodiac and labelled with their names. Arcs of longitude, which radiate from the zenith, are drawn for every 3° and are numbered separatey for each sign.

Concentric circles of celestial latitudes are drawn for each 1°. Every sixth circle is highlighted with dots. The circles are numbered from the ecliptic up to the North Pole as 1, 2, 3, 4, 5, 6; thereafter only in even numbers 8, 10, 12, … 90. Outside the ecliptic, in the lower half, each circle is numbered serially from the ecliptic onwards from 1 to 48.

The label *ṣafīḥat mīzān al-ᶜankabūt* is engraved in the lower half of the plate.

Plate 6b with the Tablet of Horizons

On the reverse side of the sixth plate are drawn half horizons for every single degree of latitude from 2 to 90, in the following four separate sets:

2	6	10	…	82	86	90;
3	7	11	…	83	87	90;
4	8	12	…	84	88	90;
5	9	13	…	85	89	90.

In all the four quadrants, declination scales are engraved along the radii, once outside the equator, i.e., to the south of the equator, and once inside, i.e., to the north of the equator.

These scales carry the values 3, 6, 9, 12, 15, 18, 21 and 23;30, the last being the value of maximum obliquity. Each scale is accompanied by a label in florid calligraphy, those to the south of the equator reading *taqsīm mayl kullī janūbī* (divisions of the obliquity, i.e. declination scale, south) and those to the north *taqsīm mayl kullī shamālī* (divisions of the obliquity, i.e. declination scale, north).

The designation of the plate *ṣafīḥa āfāqī* is engraved in the lower right quadrant.

Plate 2a for Latitude 0°

Plate 2a carries projections for latitude 0°. Combined projections for latitudes 0° + 90° or for 0° + 72° + 90° occur in some astrolabes, but this is the only case where

projections are made exclusively for latitude 0°. As in the other latitude plates, here also latitude circles are drawn for each 1°and numbered on the right and on the left; with every sixth line highlighted with dots. Azimuth arcs are drawn for every 6°; above the horizon they are drawn all over, but below the horizon only inside the circle of equator and labelled.

Figure A093.6 – Plate 2a for Latitude 0°
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Photo courtesy of the Khalili Family Trust © Nour Foundation

In the lower half, a series of 30 *ghaṭīs* lines are drawn and numbered from the western horizon, from 1 to 30. Because two and half *ghaṭīs* make one hour, certain *ghaṭī* units (i.e., 3, 8, 13, 18, 23, 28) are divided into two parts to synchronize with the equal hours, because 2 ½ gh = 1h; 5 gh = 2 h, 7 ½ gh = 3 h; 10 gh = 4 h; 12 ½ = 5 h, and so on. Thus from these lines time can be measured in both the *ghaṭīs* and hours. The

numbers of the *ghaṭīs* are engraved below the circle of the equator and those for the hours above the equator.

However, the astrolabe maker erred in drawing the *ghaṭī* lines here as unequal units, for the *ghaṭīs* are always equal and never unequal. In the other Lahore astrolabes, lines are drawn correctly for equal *ghaṭīs.*

At the middle of the plate, the specifications of the plate are given as *sāᶜāt 12;0* and *al-ᶜarḍ 0;35.* The plate is clearly calibrated for the latitude 0°, i.e., the terrestrial equator; but it is not clear why the latitude is mentioned here as ‘0;35’. Moreover, in 0;35 the zero symbol is unlike the symbol engraved throughout this astrolabe, e.g. in 12;0 just across the line of the meridian. It is written not to the right of ‘35’ but just above it, in a smaller size, as if in an afterthought.

Plate 1a

This plate is specially designed for use in conjunction with the two *zawraqī* horizons inserted in the rete for the latitudes 29° and 32°. Like the other plates, this one is also engraved with the vertical and horizontal diameters, and the three concentric circles of the Tropic of Cancer, the celestial equator and the Tropic of Capricorn.

Around the circle of equator, the twelve astrological houses are marked, once outside the equator and once inside the equator, but with a difference. Outside the equator the enumeration commences from the east point and proceeds counterclockwise, but inside the equator the enumeration commences from the west point and proceeds counterclockwise. The two varying sets of the astrological houses are related to the two oblique horizons engraved on this plate. The names of the astrological houses are engraved in elongated letters so that the names occupy the full stretches of the corresponding houses.

In both cases, each house is divided into 5 units of 6° and the numbers in *abjad* notation are engraved above the names of the astrological houses in Arabic. In Arabic, the first house is named *al-ṭāliᶜ,* ‘the ascendant,’ and the rest are ordinal numbers.

Figure A093.7 – Plate 1a to be used with the *Zawraqī* Horizons
The Nasser D. Khalili Collection of Islamic Art, Accession No. SCI 53
Photo courtesy of the Khalili Family Trust © Nour Foundation

Two mutually intersecting oblique horizons are drawn across the plate. As in the rete, here also the arc with the convex side to the north is the oblique horizon for the latitude 29° and that with the convex side to the south is the horizon of the latitude 32°. Where the arcs intersect with the equinoctial colure, there are labels at the end of each horizon. Thus at the two ends of the horizon for 29° are engraved *ufq sharqī ᶜarḍ 29* on the east, meaning “eastern horizon latitude 29” and *ufq gharbī ᶜarḍ 29* on the west, meaning “western horizon latitude 29”. Likewise at the two ends of the horizon for 32° are engraved *ufq sharqī ᶜarḍ 32* on the east and *ufq gharbī ᶜarḍ 32* on the west.

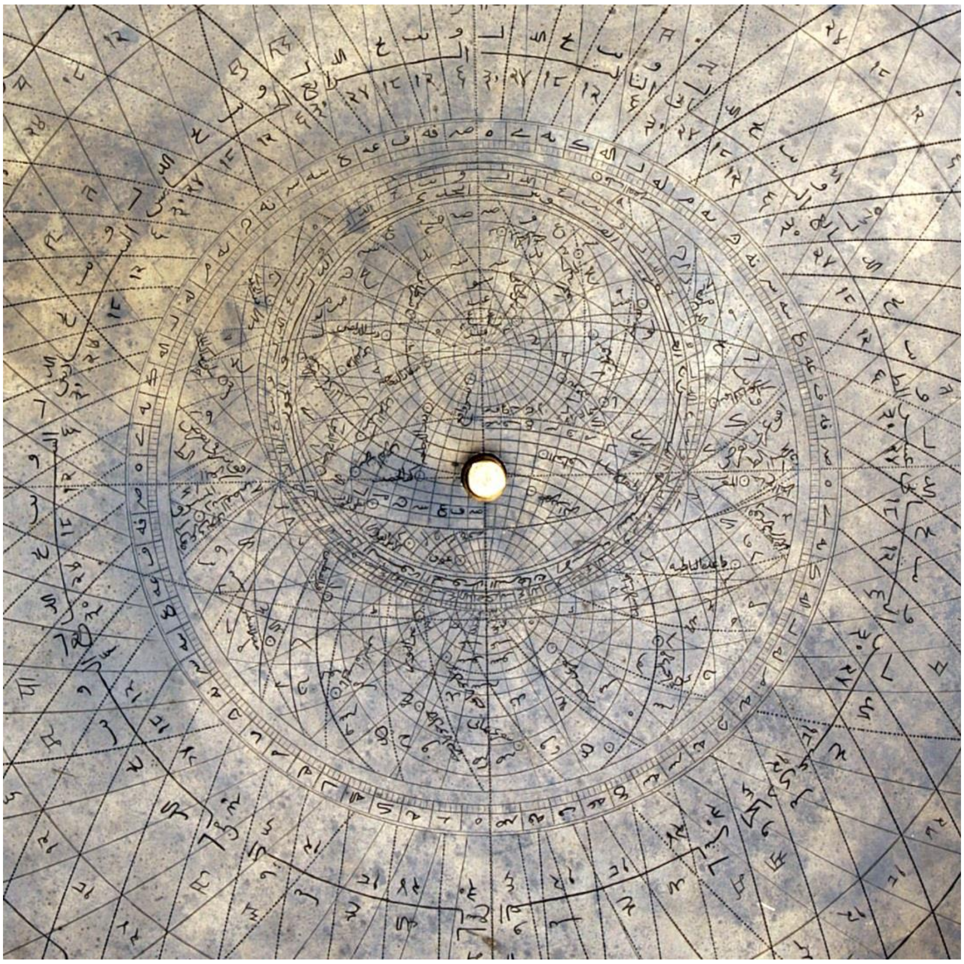

Figure A093.8 – Plate 1a (detail showing the astrological houses and the miniature tablet inside the Tropic of Cancer)
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The rim of the Tropic of Cancer is divided in 360°; each 1° marked and groups of 5° numbered from 5 to 90 counterclockwise, separately for each quadrant. Inside this ring of Cancer a miniature tablet is drawn with smaller versions of the two oblique horizons to match those on the rete, and the corresponding altitude circles. Like the larger horizons drawn across the whole the plate, the oblique horizons in the miniature plate also carry labels on both sides. The ecliptic ring is drawn on this miniatature tablet; it is divided into the 12 signs and labelled with their names. Each sign is divided into groups of 6° and numbered. Some 35 star positons are marked within the Tropic of Cancer with dots enclosed in circles along with their names.

Figure A093.9 – The Designation of Plate 1a
The Nasser D. Khalili Collection of Islamic Art, Accession No. SCI 53
Photo courtesy of the Khalili Family Trust © Nour Foundation

At the bottom of the plate is a long inscription bearing the designation of this special plate: *ṣafīḥa maṭraḥ al-shu*^{c}*ā*^{c} *keh nazd abī rayhān taswīyat al-buyūt khwānand,* “plate for finding the projection of the astrological rays according to (?) Abū Rayhān [al-Bīrūnī] [and] equalization of the astrological houses”.

GEOGRAPHICAL GAZETTEER

On the inner face of the mater is engraved the geographical gazetteer with the names of 259 localities (*asmā’ al-buldān*), their longitudes (*al-ṭūl*), latitudes (*al-*^{c}*arḍ*) and the duration of the longest day (*al-sā*^{c}*āt*) in five circles.[457] Each circle contains four rows of cells to accommodate the four elements of the gazetteer. The cartouche-like cells are created by intertwining chains drawn by two parallel lines.[458] Again in each circle, the design of the cartouches varies. The letters are oriented towards the centre of the astrolabe.

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457 Maddison & Savage-Smith 1997, I, p. 230, erroneously state that the gazetteer contains *inḥirāf,* but that is not the case.

458 The design of the cells as small cartouches has a distinct resemblance to the design in the preceding astrolabe A092.

Figure A093.10 – The Geographical Gazetteer on the Mater (detail)
The Nasser D. Khalili Collection of Islamic Art, Accession No. SCI 53
Photo courtesy of the Khalili Family Trust © Nour Foundation

This is the largest gazetteer engraved by Ḍiyā’ al-Dīn. As in A062 and A072, this gazetteer is arranged according to regions. The names of the regions are engraved above the names of localities, in narrow bands between the main circles. However, there is an occasional mismatch between the headings mentioning the regions and the localities listed under the heading. For example, Bajja az Barbar (010) is placed in Andalus and not in Sudan where it rightly belongs to, Qulzum (017) is mentioned under Yemen while it is situated in Egypt, and so on. Towards the end of the gazetteer also, certain localities in Makran and Sindh are not correctly placed.

In A062 and A072, the duration of the longest day is not given (*al-sā*^{c}*āt*). This parameter occurs only in Allāhdād’s undated astrolabe (A002) and now again in the present astrolabe.

Table A093-3 Geographical Gazetteer

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	(*al-sāᶜāt*)
	First Circle			
Iqlīmhā Maghrib (the region of the Maghreb)				
1	Sūs Aqṣā	15;30	32;0	14;08
2	Fās Qaṣba Tanja	18;00	22;0	13;22
3	Tāhart ᶜŪliyā’	35;30	29;0	13;53
4	Tāhart Suflī az Farīfta	36;0	29;0	13;53
5	Sijilmasa	37;0	31;30	14;6
6	Qayrawān	41;0	31;30	14;7
7	Mahadiyya	42;0	32;30	14;11
8	Ṭarābulus Maghrib	45;0	32;0	14;8
Andalus (Andalusia)				
9	Qurṭaba Dār al-Mulk Andalus	38;26	35;0	14;25
10	Bajja az Barbar[459]	65;0	14;0	14;54
Sūdān (Sudan)				
11	Jarmī Dār al-Mulk Habasha	65;0	9;30	12;10
12	Durqula Shahr Nūba	53;40	14;30	12;56
Miṣr (Egypt)				

459 It is wrongly included in Andalus; it belongs to the next region Sudan.

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	(*al-sāᶜāt*)
13	Qūṣ az Ṣaᶜīd Miṣr	61;30	24;30	13;32
14	Iskandariyya	61;54	30;58	14;2
15	Miṣr	63;20	30;20	14;1
16	Dumyāṭ	63;30	31;25	14;5
Yaman (Yemen)				
17	Qulzum az Kanār Darya[460]	64;0	29;30	13;55
18	ᶜAdan	76;0	11;0	12;00
19	Ṣanᶜā’ Dār al-Mulk Yaman77;0	14;30	12;56	
20	Zubayd	74;20	14;10	12;55
ᶜUmān (Oman)				
21	Ṣajā Qaṣba ᶜAmmān	84;0	14;20	12;55
22	Madīnat Rasūl ᶜAlayhi al-Salām[461]	75;20	25;0	13;35
Hijāz (Hejaz)				
23	Makka Mubārak	77;10	21;40	13;20
24	Ṭā’īf	77;30	21;20	13;18
Baḥrayn (Bahrain)				

460 Qulzum should be placed in Egypt.

461 Should be placed in the next region

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	(*al-sāᶜāt*)
25	Yamāma[462]	82;30	23;30	13;28
26	Hajar Baḥrayn	83;0	25;0	13;36
27	Ḥasā Jazīra	83;30	24;0	13;31
28	Qaṭīf Baḥrayn	75;0	25;0	13;35
Shām (Syria)				
29	Bayt al-Maqdis az Filisṭīn	66;30	31;50	14;6
30	Asqalān az Filisṭīn	66;30	32;15	14;10
31	Ramla az Filisṭīn	66;50	32;10	14;9
32	Qaysāriyya	66;30	32;30	14;11
33	Tiberiyyas	68;0	32;0	14;8
34	Ṣawar	68;30	32;40	14;12
35	Ṣaydā	68;35	32;40	14;12
36	Ṭarābulus	69;40	34;0	14;19
37	Dimashq	70;0	33;15	14;16
38	Baᶜalbak	70;45	33;15	14;16
39	Ḥims	70;45	34;0	14;19
40	Anṭākiyya az Thaghūr	71;26	35;30	14;27
41	Sarmīn	71;7	35;15	14;26
42	Qinnisrīn	72;0	35;30	14;27

[462] It should be in Hejaz.

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	(*al-sāᶜāt*)
43	Ḥalab	72;10	35;50	14;26
44	Mankh	72;15	36;15	14;32
45	Raḥba	74;35	34;10	14;20
46	Ṭarṭūs	68;40	34;42	14;34
Thughūr Rūm (border lands of the Byzantines)				
47	Massīsa wa Kagharyānā	69;15	36;45	14;45
48	Malaṭiya	71;0	37;0	14;36
49	Saqalaba Jazīra Barbar Kinat	65;0	37;10	14;37
50	Rūmiya Kubrā	85;27	41;50	15;6
51	Athīna Madīnat al-Ḥikma	65;40	37;20	14;38
52	Būr Faṭbā (?) wa hua Qasṭantīn	59;50	45;0	15;30
53	Māqadūniyā	60;0	41;0	15;1
54	ᶜAmmūriya	64;0	43;0	15;15
55	Arz ar-Rūm	72;0	39;40	14;52
56	Arzankān	76;0	38;0	14;42
57	Sīwās	71;40	39;0	14;48
58	Sumaysāt	72;35	40;0	14;54
59	Qālīqalā	73;25	39;0	14;48
Jazīra (the region of ancient Mesopotamia)				
60	Qūniya	66;30	41;0	15;1
61	Ḥarrān az Jazīra	73;0	36;40	14;33

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	(*al-sāᶜāt*)
62	Raqqa	78;15	36;0	14;30
63	Rās al-ᶜAyn	74;0	36;50	14;34
64	Mārdīn	74;0	37;15	14;37
65	Qarqīsiyā	74;40	37;20	14;38
66	Niṣibīn	75;20	37;0	14;36
67	Sinjār	76;0	36;0	14;30
68	ᶜĀna	76;30	34;0	14;19
Armīniya (Armenia)				
69	Mawṣil	77;0	34;30	14;21
70	Irbīl	77;20	35;0	14;25
71	Takrīt	78;20	34;30	14;21
72	Amid	73;40	38;0	14;42
73	Malāzjird	75;0	38;45	14;46
74	Akhlāṭ	75;50	39;20	14;50
75	Arjīsh	77;0	38;30	14;44
76	Anī	79;0	41;0	15;1
77	Salmās	79;15	37;40	14;40
78	Khuway	79;40	37;40	14;40
79	Urmiya	79;45	37;0	14;36
80	Marand	80;45	37;50	14;51
Azarbayjān (Azerbaijan)				
81	Nakhjawān	81;15	38;40	14;46
82	Marāgha	82;0	37;20	14;39

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	(*al-sāᶜāt*)
83	Tabrīz	82;0	38;0	14;42
	Second Circle			
Tatimma Azarbayjān (continuation of Azerbaijan)				
84	Ardabīl	82;30	38;0	14;42
Irān				
85	Mūqān	83;0	38;0	14;42
86	Bardaᶜa	83;0	40;30	14;54
87	Jankara	83;0	41;20	15;3
88	Samkūra	83;0	41;50	15;6
89	Tiflis Dār al-Mulk il-Khān	83;0	43;0	15;15
90	Alān	83;0	44;0	15;23
Karkh (the western shore of the Tigris River ?)				
91	Saflān	83;30	39;50	14;52
92	Bākaway	84;30	39;30	14;50
Alān (?)				
93	Shamākhī Qaṣba Shīrwān	84;30	40;50	14;54
94	Bāb al-Ābwāb	85;0	43;0	15;15
Rūs (Russia)				
95	Balanjar Dār al-Mulk Khazar	85;20	46;30	15;42
96	Kūya Madīnat Rūs	87;0	43;0	15;15
97	Saqsīn	86;30	43;0	15;15

	Place Name (*asmā’ al-buldān*)	**L (*al-ṭūl*)**	**φ (*al-ᶜarḍ*)**	**(*al-sāᶜāt*)**
Bulghār (the Bulghars)				
98	Bulghār	90;0	49;30	16;9
99	Buzbāl Mābīn Rūs Bulghār	83;0	44;0	15;23
100	Sarmīn Rāyy	79;0	34;0	14;19
ᶜArāqayn (the two Iraqs)				
101	Kūfa	79;30	31;30	14;6
102	Madā’in	72;0	33;10	14;15
103	Baghdād	82;0	33;25	14;16
104	Wāsiṭ	81;30	32;20	14;10
105	Baṣra	84;0	30;0	13;58
106	Ubulla	84;0	30;15	14;1
107	ᶜAbbādān	84;30	30;0	13;18
108	Jundīsābūr	84;5	31;15	14;3
Khūzistān (a region of Iran)				
109	Tastīr	84;30	31;30	14;6
110	ᶜAskar Mukram	84;30	31;15	14;5
111	Ahwāz	85;0	31;0	14;3
112	Rāmhurmūz	85;45	31;0	14;3
113	Arrajān	86;30	30;30	14;1
114	Shāpūr	86;55	30;0	13;18
Fārs (Persia, a province in Iran)				
115	Kāzirūn	87;0	29;15	13;53
116	Nawbandjān	87;15	30;10	13;59

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	(*al-sāᶜāt*)
117	Fīrūzābād	87;30	28;10	13;50
118	Sīrāf	88;0	29;0	13;53
119	Shīrāz	88;0	29;36	13;55
120	Iṣṭakhr	88;30	35;0	13;18
ᶜIrāq				
121	Yazd	89;0	32;0	14;8
122	Shahrazūr	82;20	32;30	14;10
123	Hulwān	82;15	34;0	14;19
124	Qirmāsīn	83;0	34;30	14;21
125	Dīnawar Mā’ al-Kūfa	83;0	35;0	14;25
126	Suhraward	83;20	36;0	14;30
127	Nahāwand Mā’ al-Baṣra (?)	83;15	34;20	14;21
128	Zankān	83;40	36;30	14;32
129	Abhar	84;30	36;45	14;34
130	Hamadān	83;0	35;10	14;26
131	Karaj	84;45	34;0	14;19
132	Sāwa	85;0	35;0	14;25
133	Qazwīn	85;0	36;0	14;30
134	Aba	85;0	34;40	14;28
135	Zarbādkān	85;0	34;15	14;20
136	Semīrum	85;40	32;15	14;9
137	Iṣfahān	86;40	32;25	14;10

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	(*al-sāᶜāt*)
138	Kāshān	86;0	34;0	14;19
Dīlmān				
139	Qumm	85;40	35;45	14;28
140	Rayy	86;20	35;0	14;19
141	Ḥuwār	87;10	35;40	14;29
142	Alamūt	85;37	36;21	14;33
Kīlān (Gilan, a province in Iran)				
143	Ṭāliqān	85;45	36;10	14;31
144	Hūsum az Jīlān	85;10	37;0	14;36
145	Kajūr wa Kalār	86;50	36;25	14;32
146	Dīma Qaṣba Damāwand	87;20	37;10	14;37
Ṭabaristān (or Tapuria, southern coastal region of the Caspian Sea)				
147	Amul Qaṣba Ṭabaristān	88;20	36;15	14;31
148	Sāriya	88;0	37;0	14;36
149	Astarābād	89;35	36;50	14;35
Jurjān				
150	Abaskūn Qaṣba Jurjān	89;30	37;15	14;37
151	Jurjān	90;0	36;50	14;35
152	Samnān	88;0	36;0	14;30
Qūmis (a region in Iran)				
153	Dāmghān	88;55	36;20	14;32
154	Basṭām	89;30	36;10	14;31

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	(*al-sāᶜāt*)
	Third Circle			
Iqlīmhā tatimma Qūmis (continuation of the region of Qūmis)				
155	Biyār	89;50	38;45	14;28
156	Farāwa	90;0	39;0	14;48
157	Marīnān	90;30	37;0	14;36
Khurāsān (Khorasan, a region in Iran)				
158	Sabzawār	91;30	36;5	14;30
159	Nīshābūr	92;30	36;21	14;31
160	Ṭūs	92;30	36;0	14;30
161	Narshī (?)	92;0	35;0	14;25
162	Ṭūs Kīlakī (?)	92;0	33;0	14;3
163	Tūn	92;30	34;30	14;21
164	Qā’īn	93;20	33;40	14;16
165	Ṭabas Masīnā	94;15	33;15	14;14
166	Zūzan	93;30	35;20	14;27
167	Bushaᶜ	94;5	34;50	14;28
168	Harāt	94;20	34;30	14;21
169	Bādghīs	94;30	35;20	14;27
170	Sarakhs	94;30	37;0	14;36
171	Marw ar-Rūd	97;0	36;30	14;32
172	Marw	97;0	37;40	14;39
173	Jūzajān	98;0	35;30	14;27
174	Fāriyāb	99;0	36;45	14;33

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	(*al-sāᶜāt*)
175	Ashbūrqān	105;0	36;45	14;33
176	Balkh	101;0	36;41	14;33
177	Bāmiyān	102;0	34;35	14;20
Khatlān (a province of Tajikistan)				
178	Samankān	102;0	36;0	14;30
179	Qayādyān (?)	102;0	37;45	14;39
180	Walwārij	102;20	36;55	14;34
181	Taliqān az Tukhāristān	102;50	37;25	14;37
Khwārizm				
182	Andarāb	103;45	36;0	14;30
183	Badakhshān	104;24	37;10	14;37
184	Bulūr	108;0	37;0	14;30
185	Būkarkānj	93;0	42;35	15;10
186	Kurkanj Dār al-Mulk Khwarizm	94;30	42;17	15;9
Mā warā’ al-Nahr (what is beyond the [Oxus] river, Transoxonia)				
187	Hazār Asf	95;0	41;0	15;1
188	Kāt	95;0	41;36	15;3
189	Darqān	94;15	39;30	14;50
190	Bukhārā	97;30	39;50	14;52
191	Samarqand	99;16	39;37	14;38
192	Nasaf	98;0	39;0	14;48
193	Kash	99;30	39;30	14;50

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ʿarḍ*)	(*al-sāʿāt*)
194	Isfījāb az Shāsh	99;50	43;36	15;12
195	Ṭaraz	99;50	44;31	15;25
196	Abīr Washna (?)	105;0	40;0	14;54
197	Ṣafāniyā	105;30	38;14	14;43
198	Khujand	105;35	41;55	15;6
199	Binkat Qaṣba Shāsh	101;0	43;0	15;15
200	Tūnkat Qaṣba Aylān	101;0	43;25	15;27
201	Akhshikāt Qaṣba Farghāna	101;20	42;25	15;10
	Fourth Circle			
Iqlīmhā tatimma mā warā’ al-Nahr (continuation of of the region of Tansoxania]				
202	Ūzkand	102;50	44;0	15;28
203	Ūsh	102;20	43;20	15;12
204	Kāshghar	106;30	44;0	15;28
Tabaraknān (?)				
205	Jāj wa hua Shāsh	109;0	42;30	15;8
206	Khutan	107;0	42;0	15;8
207	Almāligh	102;30	44;0	15;28
208	Qabāligh	108;0	44;0	15;28
209	Ushsh Kalūrān	110;0	46;0	15;38
210	Pīsh Bāligh	102;0 !	45;50	15;35
211	Qarāqūrūm	112;0	46;0	15;38

	Place Name (*asmā’ al-buldān*)	**L (*al-ṭūl*)**	**φ (*al-ᶜarḍ*)**	**(*al-sāᶜāt*)**
212	Khān Bāligh	124;0	46;0	15;38
213	Nankyās	130;0	39;0	14;48
Kirmān (a province in Iran)				
214	Mahrī	140;0	30;0	13;58
215	Shīrjān	90;20	29;30	13;55
216	Hurmūz	92;0	25;0	13;35
217	Bardsīr	92;30	29;50	13;57
218	Jīruft	93;0	27;30	13;45
219	Bam	94;0	28;30	13;51
220	Narmāshīr	94;20	29;0	13;53
221	Khabīṣ	93;0	31;0	14;3
222	Zaranj Madīnat Sijistān	90;0	32;30	14;10
Zābalistān (a region in Afghanistan)				
223	Bust	100;0	33;0	14;13
224	Takinābād	101;55	33;20	14;15
225	Maymand	101;55	33;20	14;15
226	Ghazna Qaṣba Zābalistān	104;20	33;35	14;16
227	Banjahīr az Kābulistān	104;40	35;0	14;25
228	Ribāṭ Amīr	105;0	34;0	14;19
229	Tabar Qaṣba Makrān	98;0	26;15	13;41
230	Kīj az Makrān	99;0	28;0	13;49

	Place Name (*asmā’ al-buldān*)	L (*al-ṭūl*)	φ (*al-ᶜarḍ*)	(*al-sāᶜāt*)
Makrān (coastal strip in the south of Sindh and Baluchistan, Pakistan)				
231	Jālq az Makrān	99;0	30;0	13;58
232	Daybul wa Hūtana ?	102;30	25;10	13;36
233	Manṣūra Qaṣba Sind[463]	105;0	27;40	13;48
234	Tāna az Sāḥil Bahr Hind[464]	102;0	19;20	13;12
Sind (Sindh)[465]				
235	Nahlāwārā	102;30	22;0	13;22
236	Sawmnāt	106;0	17;0	13;2
	Fifth Circle			
Iqlīmhā tatimma Sind (continuation of the region of Sindh)				
237	Mūltān	107;35	29;40	13;46
238	Qandahār	107;40	33;0	14;13
239	Lahūr Dar al-Salṭanat	109;20	31;50	14;54 !
Hind (India, south of the Indus)				
240	Qannawj	102;50 26;35	13;42	
241	Bānārasī	117;20	26;55	13;45
242	Sarandīp	130;0	10;0	12;40

463 Manṣūra should be in Sindh.

464 ‘Tāna on the shore of the ocean of Hind’. It is actually Thane, near modern Mumbai; wrongly placed in Makrān.

465 The two places are in Gujarat, i.e., in the region Hind and not in Sindh.

	Place Name (*asmā’ al-buldān*)	**L (*al-ṭūl*)**	**φ (*al-ᶜarḍ*)**	**(*al-sāᶜāt*)**
243	Kashmīr	108;0	35;0	14;25
244	Tubbat	110;0	40;0	14;54
245	Akbarābād Dar al-Khilāfat	114;0	27;0	13;45
246	S[h]āhjahānābād Dar al-Mulk Hind	113;0	28;39	13;52
247	Ajmīr	112;0	26;0	13;31
248	Kawāliyār	115;0	26;29	13;42
249	Burhānpūr	109;0	20;31	13;14
250	Sūrat	110;50	20;15	13;14
251	Dawlatābād	111;0	20;30	13;14
252	Ujjayn	112;0	22;30	13;24
253	Bījāpūr	115;30	17;20	13;42
254	Kūlkandā	114;39	18;4	13;9
255	Dhākā Bankālā	130;0	27;0	13;45
256	Patnā	120;45	26;40	13;44
257	Jawnpūr	119;6	26;36	13;44
258	Munkīr	121;45	26;40	13;44
259	Allāhābād	115;34	26;50	13;44

BACK

On the back of the astrolabe, the two altitude scales on the upper half of the rim contain three concentric bands as on the limb. The innermost band is divided into 0.25°, the middle one into single degrees and labelled in standard Arabic numerals and in the

outermost band groups of 3° are marked in *abjad* notation from 3 to 90, separately in each quadrant, starting from the east and west points and reaching the south point at the top.

Figure A093.11 – The Back of the Khalili Astrolabe
The Nasser D. Khalili Collection of Islamic Art, Accession No. SCI 53
Photo courtesy of the Khalili Family Trust © Nour Foundation

On the upper left is the trigonometric quadrant, with 60 equally spaced horizontal parallel lines and the same number of equally spaced vertical parallel lines, with every third line dotted. Two radial lines divide the quadrant into three segments of 30° each. The 60 vertical lines are numbered along the radius at the bottom of the quadrant, first in standard Arabic numerals from 1 to 60 and then in groups of 3 in *abjad* notation, both times starting from the apex of the quadrant and then proceeding towards the circumference. The horizontal parallels are numbered in the same manner along the vertical radius on the right.

Figure A093.12 – The Trigonometric Quadrant on the Back
The Nasser D. Khalili Collection of Islamic Art, Accession No. SCI 53
Photo courtesy of the Khalili Family Trust © Nour Foundation

On the upper right is the solar quadrant, consisting of 90 equally spaced concentric declination arcs, one for each 2° of solar longitude. Every fifth arc is highlighted with dots. The names of the corresponding zodiac signs and the numbers of their subdivisions are engraved along the two radii.

Figure A093.13 – The Solar Quadrant on the Back
The Nasser D. Khalili Collection of Islamic Art, Accession No. SCI 53
Photo courtesy of the Khalili Family Trust © Nour Foundation

Upon this grid are plotted three sigmoid graphs for the meridian altitude of the Sun throughout the year for the latitudes of 27°, 29° and 32° along with the labels *khaṭṭ nisf al-nahār bi-ᶜarḍ 27* (line of midday at latitude 27°), *khaṭṭ nisf al-nahār bi-ᶜarḍ 29*, and *khaṭṭ nisf al-nahār bi-ᶜarḍ 32* respectively.

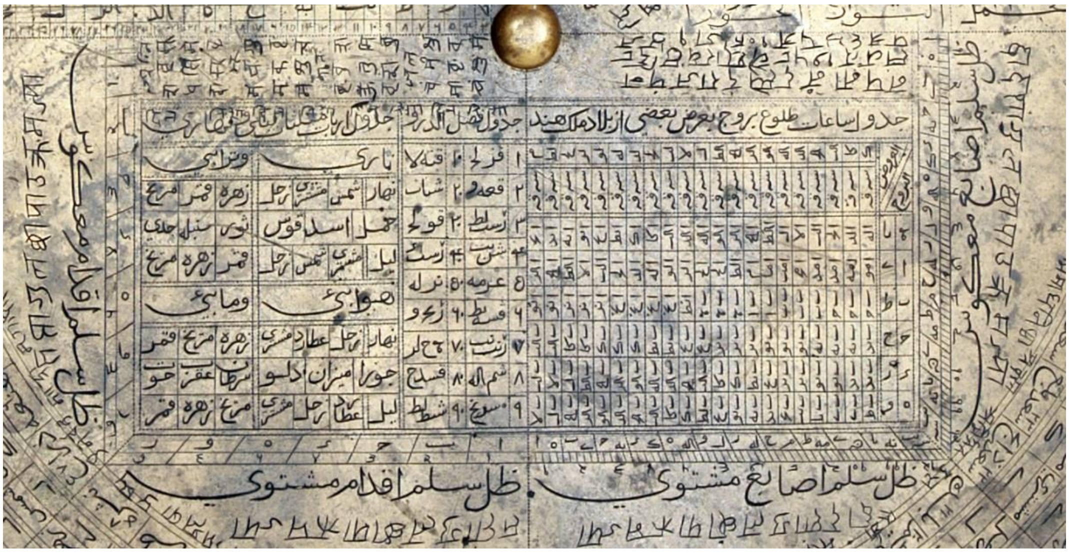

Figure A093.14 – Shadow Squares on the Back
The Nasser D. Khalili Collection of Islamic Art, Accession No. SCI 53
Photo courtesy of the Khalili Family Trust © Nour Foundation

In the lower half, there are two shadow squares, on the left for a gnomon of 7 feet and on the right for a gnomon of 12 feet. The four scales are divided and numbered accordingly and are accompanied by the following labels:

Vertical scale on the left: *ẓill sullam aqdām ma*ᶜ*kūs*
Horizontal scale on the left: *ẓill sullam aqdām mustawī*
Horizontal scale on the right: *ẓill sullam aṣabi*ᶜ *mustawī*
Vertical scale on the right: *ẓill sullam aṣabi*ᶜ *ma*ᶜ*kūs*.

Inside these shadow squares are engraved three tables. The first table from the right is designated as *Jadwal sā*ᶜ*āt ṭulū*ᶜ *burūj bi-*ᶜ*arḍ ba*ᶜ*ḍī az bilād mulk Hind* (table of times of rising of the signs for the latitudes of some localities in India). In 8 columns and 23 rows, this table gives the rising times of the signs from latitudes 21° to 40°.[466]

The second table, named *Jadwal faḍl al-dawr*[467] (table of excess of revolution), displays the multiples of differences, in minutes and seconds, between the approximately correct length of the tropical year and 365 days.[468] The number of days is written in standard Arabic numerals and the difference in *abjad* notation.

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466 Ḍiyā’ al-Dīn’s astrolabe of 1656 at Jai Singh’s Observatory at Jaipur (A072) has a similar table for the latitudes of 29° to 39°; it is reproduced in Kaye 1918, p. 23.

467 On the astrolabe the name is engraved as *Jadwal faḍl al-darū,* obviously by mistake.

468 See Kaye 1918, p. 24; Sarma 2003, pp. 50-52.

The third table inside the shadow squares, designated as *Jadwal arbāb al-muthallathāt laylī wa nahārī* (table of regents of the triplicities by day and by night), shows the signs grouped as triplicities and their planetary regents of the day and of the night.[469]

These tables along with the additions in Sanskrit will be discussed in E004

Figure A093.15 – Scales in the Lower Half of the Back
The Nasser D. Khalili Collection of Islamic Art, Accession No. SCI 53
Photo courtesy of the Khalili Family Trust © Nour Foundation

The rim of the lower half contains two cotangent scales; that on the left is designated as *ẓill aqdām mabsūṭ* (horizontal shadow in feet), with unequal divisions numbered from the vertical radius clockwise from 1 to 24, 26, 28, 30, 33, 36, 42, 48, 54, 64?, 69?, 70, ?, 90, followed by the designation. The scale on the right is named *ẓill*

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469 See Kaye 1918, p. 23, where the same table from Ḍiyā’ al-Dīn’s astrolabe of 1656 at Jai Singh’s Observatory at Jaipur is reproduced.

aṣābi^c mabsūṭ (horizontal shadow in digits), with unequal divisions numbered from the vertical radius counterclockwise as 1-30, thereafter 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 54, 56, 60, 63, 66, 72, 78, 84, 90, followed by the designation.

The space between the rim containing the cotangent scales and the two shadow squares is filled with seven semicircular scales; each two rows are separated by a narrow band.

The first scale, as counted from the outside, consists of three rows. While the third row is filled with the 12 names of the signs of the zodiac, the first row is divided into single degrees and in the second row groups of 5° are numbered, separately for each sign (as, 5, 10, 15, 20, 25, 30).

The remaining scales show various kinds of subdivisions of the signs and their regents or functions: one-twelfth parts (duodenaries, Sanskrit: *dvādaśāṃśa*); [470] one-ninth parts (novenaries, Sanskrit: *navāṃśa*); terms or limits, i.e., one-fifth parts of the signs and the strengths of planets which preside over these limits (the name *ḥudūd miṣriyān* is engraved in the first cell of the row);[471] planets and their domiciles in one-thirds of the signs (the name *darjān kawākib* is engraved in the first cell);[472] and finally the regents of the decans of 10° (the designation *wujūh kawākib* is engraved in the first cell) .[473] The very last semi-circular scale carries the names of 28 lunar mansions in Arabic followed by their serial numbers.

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470 The *Zarqālī* astrolabe made by Ḍiyā’ al-Dīn in 1680 which is now in Jai Singh’s Observatory [A091] carries a table of duodenaries; it is reproduced in Kaye 1918, p. 125.

471 See Kaye 1918, pp. 122-123; Sarma 2003, p. 49.

472 See Kaye 1918, p. 126.

473 See Kaye 1918, p. 123; Sarma 2003, p. 50.

A094 ASTROLABE ATTRIBUTABLE TO ḌIYĀ’ AL-DĪN MUḤAMMAD[474]

Date not available, 17th century

Diameter ?

PLU

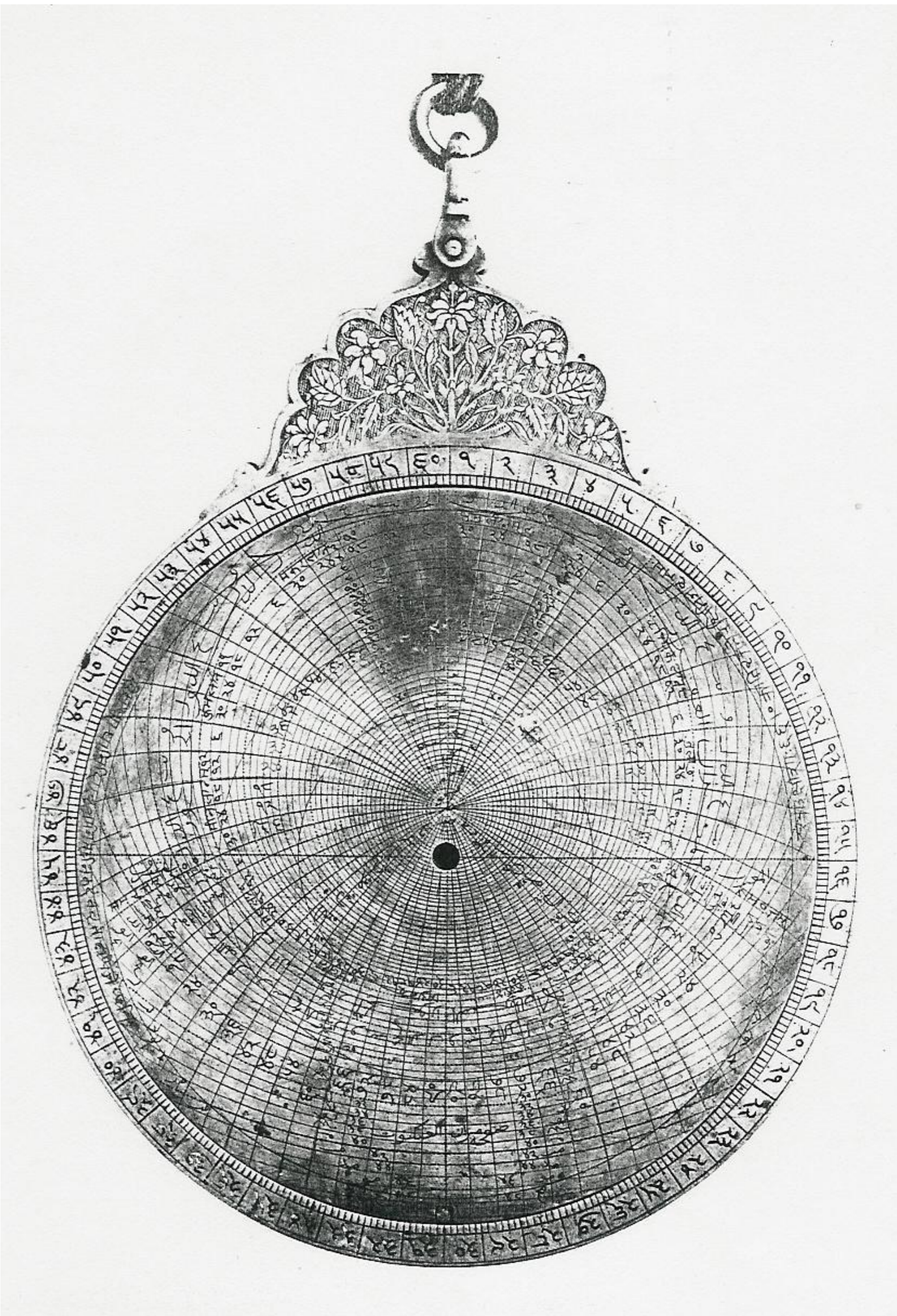

Figure A094.1 – Mater with the tablet of ecliptic coordinates
(photo courtesy Museum of the History of Science, Oxford)

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474 Entry based on two photos in the archives of the Museum of the History of Science, Oxford.

Like the previous astrolabe, this too was reworked with Sanskrit labels, but more elegantly and in a scholarly manner. Even so, here also the name of the maker and the date of production had been erased, but it is easier to identify the maker of this astrolabe. The decoration on the *kursī* with large flowers and leaves points unambiguously to Ḍiyā’ al-Dīn. Similar floral decorations can be seen on Ḍiyā’ al-Dīn’s astrolabes A072, A075, A077 and A092. It is not known how large this astrolabe is; it must have been a fairly large one, of about 250 to 300 mm in diameter, in order to accommodate all the astrological scales on the back.

In the present entry, the original features of the Indo-Persian astrolabe will be described as far as available; the reworking in Sanskrit and the labels added in Devanagari will be discussed in E005.

FRONT

The suspensory mechanism includes a cord, a ring and shackle, the last two with a diamond cross-section. The *kursī* is solid with a trifoliate finial and lobed profiles. The front and back of the *kursī* are decorated with slightly different designs of bouquets with large flowers and leaves.

Originally the limb on the front and altitude scales on the back are divided in 1° and 5° and the groups of 5° are separated by dotted lines and numbered in *abjad* numerals. In the process of reworking, the degree scale on the front is partially ground; the original divisions of 1° are retained, but the original divisions of 5° are replaced by divisions of 6° and numbered in Devanagari from 1 to 60 in according with the practice of Sanskrit astrolabes. On the back, the original altitude scales are retained, but Devanagari numerals are added next to the *abjad* symbols.

PLATES

A Devanagari inscription added on the back states that there were seven latitude plates (*akṣa-patra*) and one rete (*bha-patra*) in this astrolabe. Photo is available only of the tablet of ecliptic coordinates. On this plate, the horizon coincides with the ecliptic. Parallel to the ecliptic, latitude circles are drawn for every 2°. Longitude arcs are drawn for every 6°. The names of the 12 zodiac signs are engraved along the ecliptic circle; the 6° divisions are numbered as 6, 12, 18, 24, 30 separately for each sign. A little above the north point is engraved the name of the plate *ṣafīḥat mīzān al-ᶜankabūt.*

Back

On the back, the rim of the upper half contains altitude scales divided 1° and 5° and labelled as 5---90; 90---5.

The trigonometric graph in the upper left is engraved with 60 horizontal and 60 vertical parallels with every fifth line highlighted with dots. These lines are numbered in 5s from 5 to 60 along both the radii.

In the solar quadrant in the upper right, declination arcs are drawn for every 6° of solar longitude; those for 30° are highlighted with dots. The names of the corresponding zodiac signs and their subdivisions, each of 6°, are marked along the two radii. Three curves of the midday altitude of the sun throughout the year at latitudes 27°, 29° and 32° are drawn across this quadrant, accompanied by labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27, bi-ᶜarḍ 29* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ 32* respectively.

In the lower half are drawn two shadow squares, on the left for a gnomon of 12 digits and on the right for a gnomon of 7 feet. The four scales on the left and right are divided accordingly and are accompanied by the following labels:

Vertical scale on the left: *ẓill sullam aṣābiᶜ maᶜkūs*
Horizontal scale on the left: *ẓill sullam aṣabiᶜ mustawī*
Horizontal scale on the right: *ẓill sullam aqdām mustawī*
Vertical scale on the right: *ẓill sullam aqdām maᶜkūs*

Inside the shadow squares is a rectangular table with the heading *jadwal faḍl al-dawr* (table of excess of revolution).

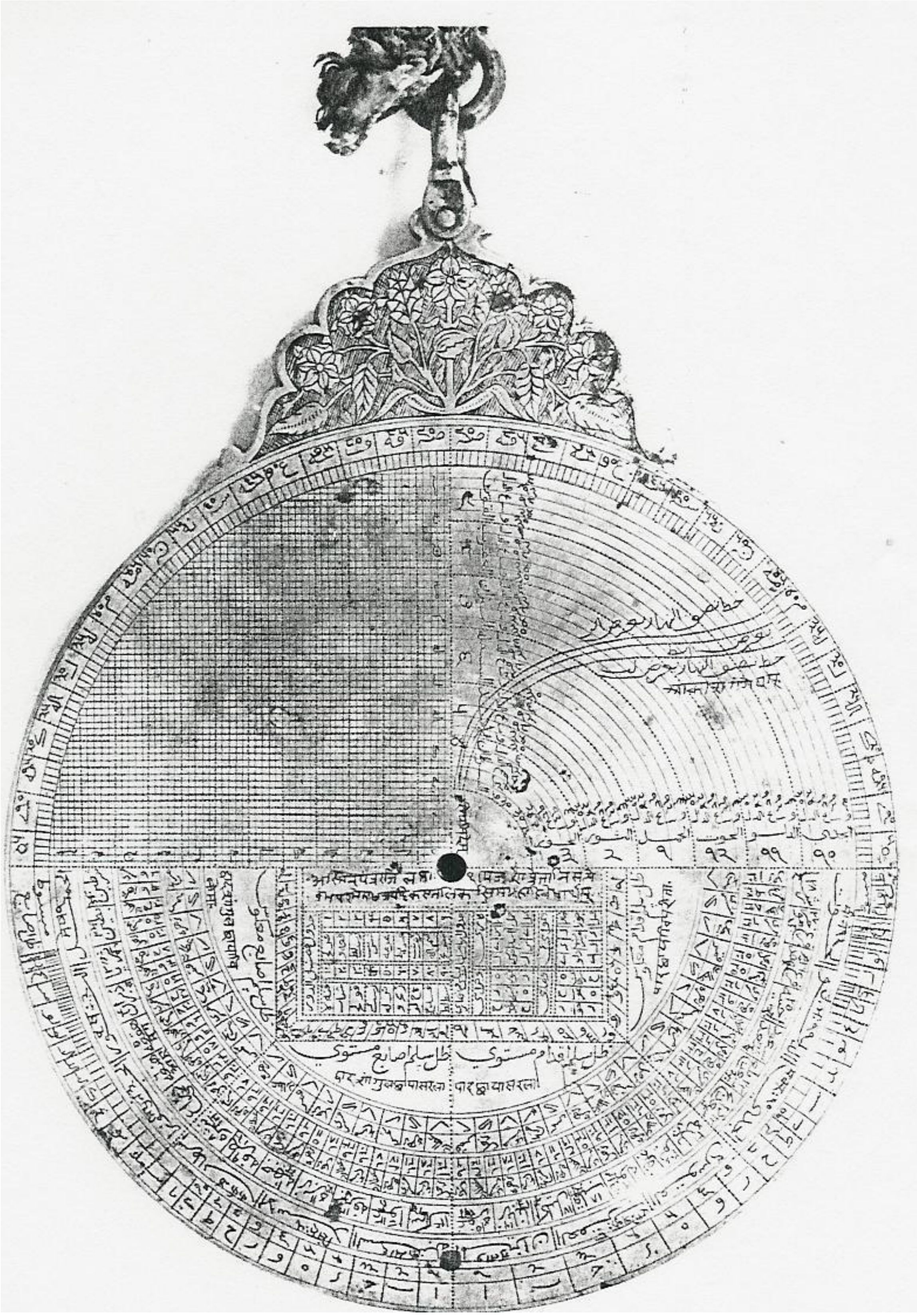

Figure A094.2 – Back of the astrolabe
(photo courtesy Museum of the History of Science, Oxford)

The shadow squares are enclosed by 9 semi-circular scales. Starting from the outside, the first two rows on the rim carry the cotangent scales and their subdivisions,

on the left in digits and on the right in feet. The unequal divisions on the left are numbered 1, 2, 3, … 12, 14, 16, 18, 20, 22, 24, 24 (sic!), 26, 36, 42, 48, 54, 60, followed by the label *ẓill aṣābi*[c] *mabsūṭ.* The unequal divisions on the right are numbered 1, 2, 3, … 10, 12, 14, 16, 18, 21, 24, 30, 36, 38, followed by the label *ẓill aqdām mabsūṭ.*

Rows 3 and 4 are engraved with the names of the 12 signs of the zodiac and those of the 28 corresponding lunar mansions.

Rows 5, 6 and 7 contain the table of the limits: in row 5 are the full names of the 5 planetary regents of each sign, in row 6 their individual limits in *abjad,* and in row 7 their cumulative limits in common Arabic/Persian numerals. For example, the limits of the sign *al-Ḥamal* (Aries) are shown thus:

***Al-Ḥamal* (Aries)**				
Mushtarī (Jupiter)	*Zuhara* (Venus)	*[c]Uṭārid* (Mercury)	*Mirrīkh* (Mars)	*Zuḥal* (Saturn)
6	6	8	5	5
6	12	20	25	30

Finally, in the last two rows are the decans or faces and their regents. The names of the planetary regents are engraved in full in row 8 and the numerical division into the decans 10, 20, 30 are engraved decoratively in a zig-zag manner in row 9. Narrow blank bands are inserted between certain rows so that the engravings in these semi-circular rows do not look too cluttered.

PROVENANCE

The two photos of this astrolabe are in the archives of the Museum of the History of Science, Oxford, in what is known as ‘G. R. Kaye Album’. Kaye is well known for his celebrated study of Jai Singh II astronomical observatories entitled *The Astronomical Observatories of Jai Singh.* In this study, he also described some astrolabes which were collected by Jai Singh and which were preserved in Jaipur in 1918. After his death, his widow gifted a box of photographs to the Museum of the History of Science at Oxford. This box contained several sepia-tinted photographs of the astrolabes described and illustrated by Kaye in his book. Obviously these photographs were made during December 1915-January 1916 when Kaye was in Jaipur. Besides these photographs, I

found in the box, two photographs showing front and back of the present astrolabe. Since this astrolabe is not mentioned by Kaye in his book, he may have acquired these photos after the book was completed.

The scholarly and careful manner in which the Sanskrit inscriptions are added suggests that the reworking must have been done probably at Jai Singh’s court at Jaipur in the first quarter of the eighteenth century. The astrolabe is not with Jai Singh’s observatory at Jaipur any more. Its present location is unknown.

A095 ASTROLABE ATTRIBUTABLE TO ḌIYĀ’ AL-DIN MUḤAMMAD

Not dated, 17th century

Diameter 174 mm

Oxford, Museum of the History of Science (#33411)

Figure A095.1 – Front of the astrolabe (photo by S. R. Sarma)

This astrolabe is not signed, nor dated. It bears on the back sigmoid curves of the midday altitude of the sun for as many as nine different latitudes. Such preponderance of these curves can be seen in Ḍiyā’ al-Dīn’s astrolabe of 1651 at the Salar Jung

Museum, Hyderabad, which is engraved with curves for 8 different latitudes (A067). In the present astrolabe, the geographical gazetteer is arranged according to climates. After mentioning three places that are situated beyond the seventh climate, the gazetteer continues with the names and coordinates of 22 more places belonging mainly to India. Such additions are to the found in some gazetteers of Ḍiyā’ al-Dīn’s astrolabes, in particular the astrolabe made in 1663, now at Patna (A082). Therefore, this astrolabe may be attributed to Ḍiyā’ al-Dīn Muḥammad.

It has some unusual projections on three plate faces: projection for latitude 90°, triple projection for latitudes 0°, 48° and 90°, and a double projection for latitudes 24° and 30° showing the 12 astrological houses pertaining to both these latitudes.

COMPONENTS

Body with crown (d. 174, h. 198, t. 11), ring and shackle, rete (d. 158) for 44 stars, 7 plates, alidade (length 166) with a sighting tube, pin and horse. All parts are in good condition. The rete and the plates (except no. 7) feel and sound as if they are made of a lighter metal. They are brighter in colour and the engraving on these appears as if written with black ink. Compared to these, the mater is quite heavy; thicker in the middle and tapering towards the edges.

FRONT

The ring is large with a diamond cross-section; the shackle is trifoliate with a diamond cross-section. The *kursī* is solid and low; it is lobed and terminates in a trifoliate finial. The limb is calibrated for 1° and 6° and labelled clockwise from 6 to 90, separately in each quadrant.

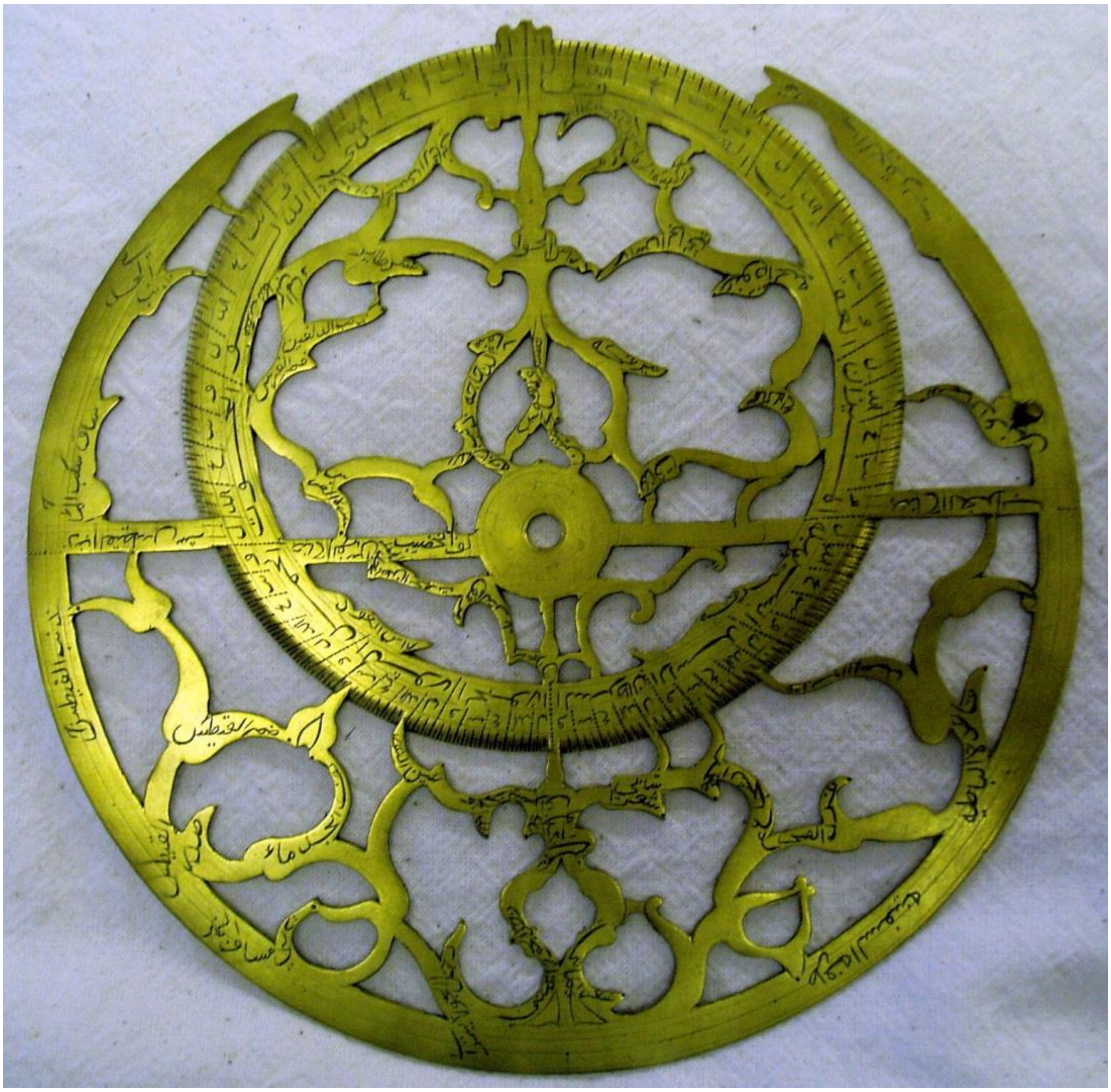

Figure A095.2 – Rete of the astrolabe (photo by S. R. Sarma)

Rete

The peripheral Capricorn ring and the ecliptic ring are held together by the equinoctial bar which has counter changes at its two intersections with the ecliptic ring. A part of the solstitial bar is also shown, joined with several star pointers. The tracery joining the star pointers is not particularly impressive. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names, each sign is divided in groups of 6° and numbered from 6 to 30; the edge of the ring is marked with divisions of 2° and 1°. There are 44 named star pointers.

Table A095-1 Stars on the Rete

	Star Names	Identification
1	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
2	*Baṭn al-Ḥūt*	β Andromedae
3	*Fam al-Qayṭus*	γ Ceti
4	*Ṣadr al-Qayṭus*	π Ceti
5	*Kaff al-Jadhmā’*	α Ceti
6	*Mirfaq*	α Persei
7	*Masāfat al-Nahr*	γ Eridani
8	*ᶜAyn al-Thawr*	α Tauri
9	*ᶜAyyūq*	α Aurigae
10	*Rijl al-Jawzā’ Yusrā*	β Orionis
11	*Yad al-Jawzā’ Yusrā*	γ Orionis
12	*Yad al-Jawzā’ Yumnā*	α Orionis
13	*Rijl al-Jawzā’ Yumnā*	κ Orionis
14	*Shiᶜrā Yamānī*	α Canis Majoris
15	*Shiᶜrā Shāmī*	α Canis Minoris
16	*Ṭarfat al-Safīna*	ρ Puppis
17	*Minkhar al-Shujāᶜ*	σ Hydrae
18	*Fard al-Shujāᶜ*	α Hydrae
19	*Qalb al-Asad*	α Leonis
20	*Qāᶜidat al-Bāṭiya*	α Crateris
21	*ᶜAnāq*	ζ Ursae Majoris
22	*Janāḥ al-Ghurāb*	γ Corvi
23	*Simāk Aᶜzal*	α Virginis

	Star Names	Identification
24	*Simāk Rāmiḥ*	α Bootis
25	*Nayyir Fakka*	α Coronae Borealis
26	*ᶜUnuq al-Ḥayya*	α Serpentis
27	*Qalb al-ᶜAqrab*	α Scorpii
28	*Rukbat al-Ḥawwā’*	ζ Ophiuchi
29	*Rās al-Jāthī*	α Herculis
30	*Rās al-Ḥawwā’*	α Ophiuchi
31	*Rās al-Tinnīn*	γ Draconis
32	*Nasr Wāqiᶜ*	α Lyrae
33	*Qarn al-Jadī al-Thānī*	α Capricorni
34	*Minqār al-Dajāja*	β Cygni
35	*Nasr Ṭā’ir*	α Aquilae
36	*Dhanab al-Dālfīn* !	ε Delphini
37	*Fam al-Faras*	ε Pegasi
38	*Dhanab al-Dajāja*	α Cygni
39	*Dhanab al-Jadī*	δ Capricorni
40	*Sāq Sākib al-Mā J[anūbī]*	δ Aquarii
41	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
42	*Janāḥ al-Faras*	γ Pegasi
43	*Surrat al-Faras*	δ Pegasi
44	*Kaff al-Khaḍīb*	β Cassiopeiae

Plates

There are seven plates with the following specifications.

Table A095-2 Plates

	φ	Longest day
1a	18°	13 hours !
1b	21°	13 hours !
2a	24°	13 hours !
2b	27°	13 hours !
3a	29°	13;52 hours
3b	32°	14;8 hours
4a	34°	14 hours !
4b	36°	14 hours !
5a	26°	13 hours !
5b	0°+ 48°+ 72°	
6a	90°	
6b	24° + 30°	
7a	Tablet of ecliptic coordinates	
7b	Tablet of horizons	

Plates 3, 4, 7 have two notches each at the north and south points. In 3 and 4 the notch at the south point is unnecessary. The tablet of horizons engraved on plate 7 ought to have four notches at the four points of the compass to be fully functional. Strangely the maximum duration of daylight is given inaccurately on plates 1, 2, 4 and 5.

On plates 1 to 5a, altitude circles are drawn for each 1° and every fifth is highlighted with dots. Azimuth arcs are drawn below the horizon for each 6°; those for 30° are dotted and extended above the horizon. Lines for seasonal hours and equal hours are drawn from the western horizon. Both sets are numbered clockwise from the western horizon in *abjad.* On plate 3 serving the latitudes of 29° (Delhi) and 32° (Lahore), there are additional lines for equal *ghaṭīs* drawn from the western horizon and numbered from there in standard Arabic/Persian numerals from 1 to 34 or 35.

Plate 7 carries the tablet of ecliptic coordinates on the obverse with the label *ṣafīḥat mīzān al-ᶜankabūt* and the tablet of horizons of the reverse with the label *ṣafīḥa āfāqī.*

Plates 5b, 6a and 6b carry unusual projections which are not met with elsewhere.

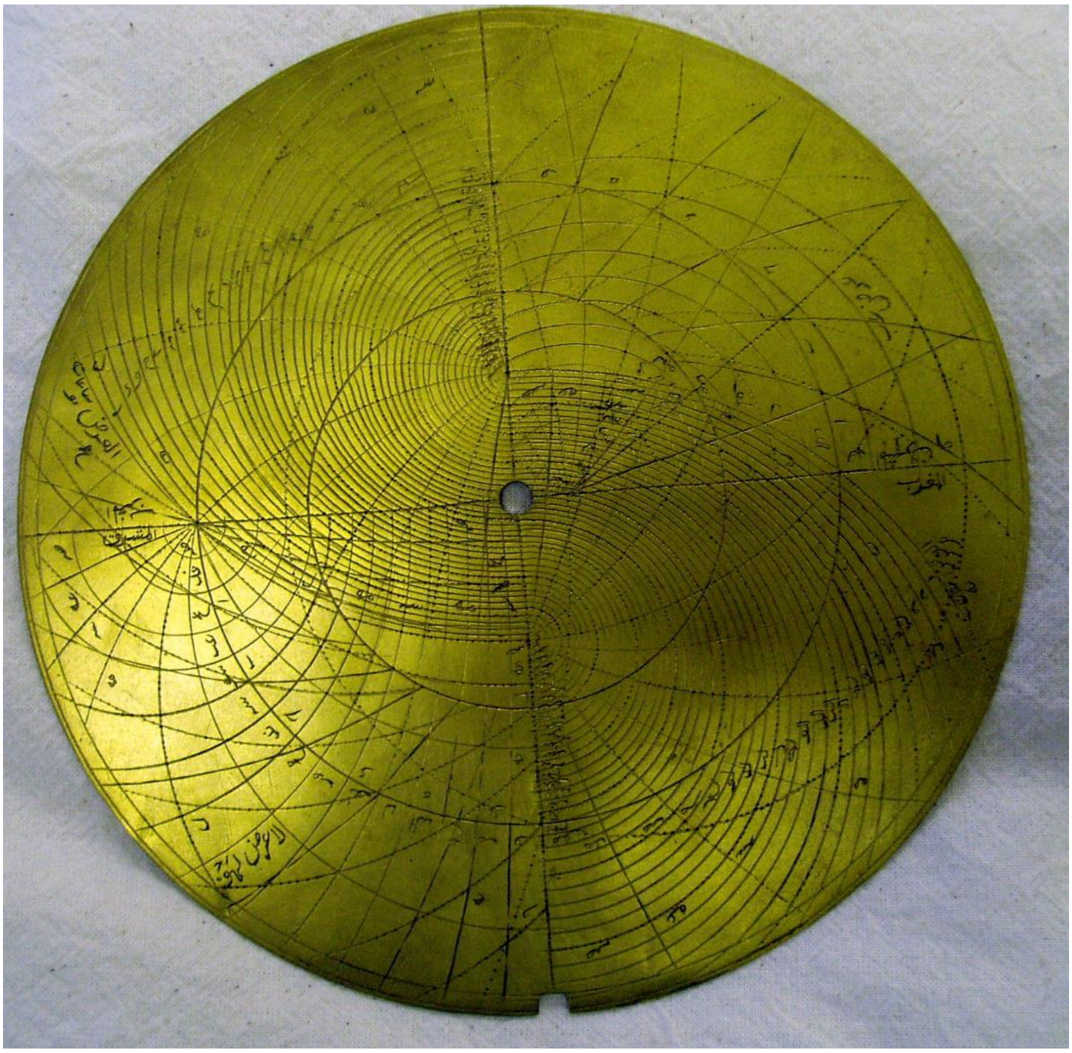

Figure A095.3 – Plate 5b with triple projection for latitudes 0°, 48° and 72° (photo by S. R. Sarma)

Plate 5b contains a combined projection for three latitudes. The lower quadrant on the left is calibrated for the latitude of 0° with altitude circles for every 6°. There is a label *lā ᶜarḍ lahū* (there is not latitude). The upper quadrant on the left carries projections for 48° with altitude circles for every 2°. There is a label *al-ᶜarḍ 48* (latitude 48) and *sāᶜāt 16* (maximum duration of daylight 16 hours). The upper and lower quadrants on the right are engraved with projections for latitude 72° with altitude circles for every 2°. In the upper right quadrant there are also lines for seasonal and equal hours. In both quadrants there are labels declaring the latitude to be 72°.

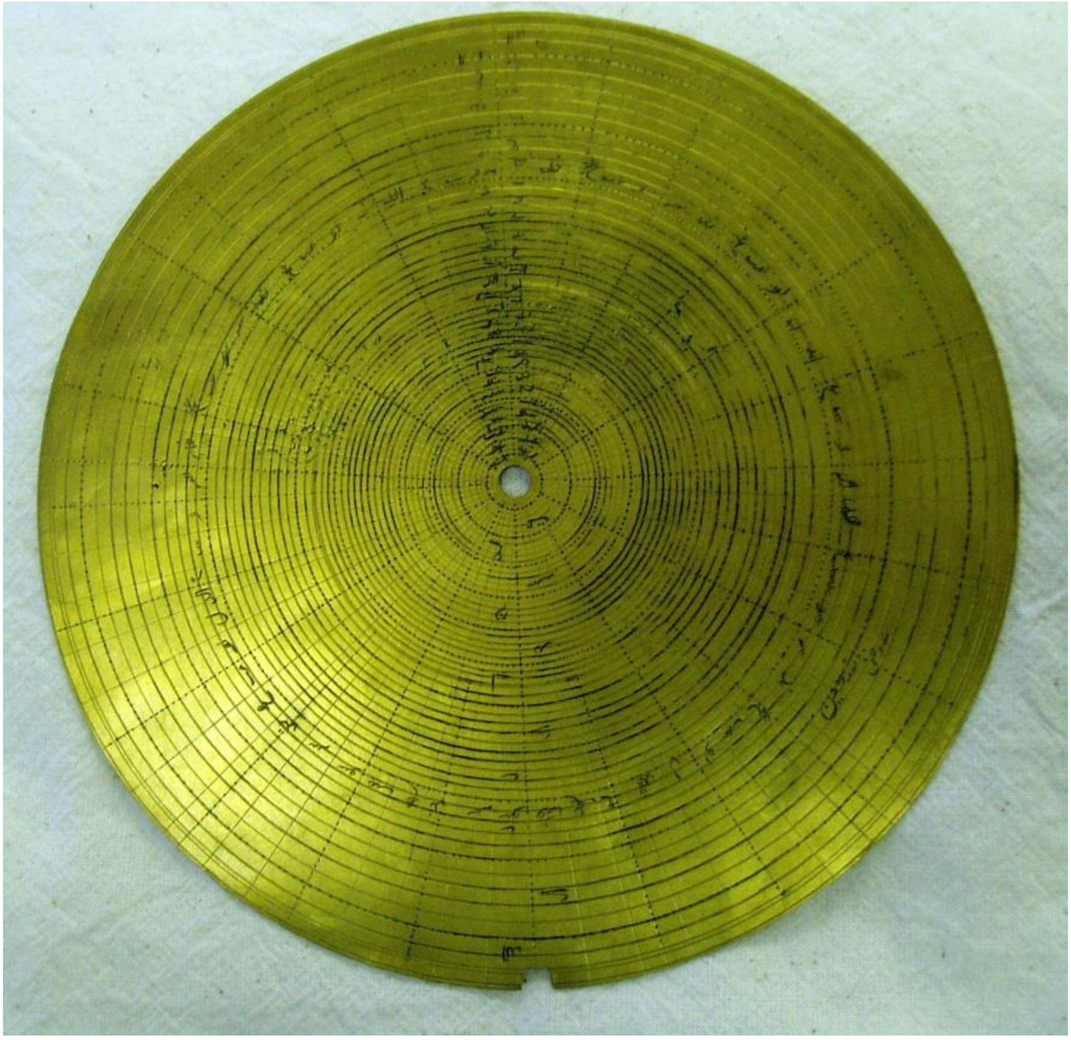

Figure A095.4 – Plate 6a for latitude 90° (photo by S. R. Sarma)

Plate 6a is calibrated for latitude 90°. Here the horizon coincides with the equator; the altitude circles merge with the declination circles and the azimuth circles with the hour lines. Therefore the altitude circles are drawn concentric around the centre; these are drawn at intervals of 2° with every fifth highlighted with dots. The azimuth arcs are radial lines from the centre; these are drawn for every 6°.

There is a label stating *ᶜarḍ tisᶜūn* (latitude ninety).

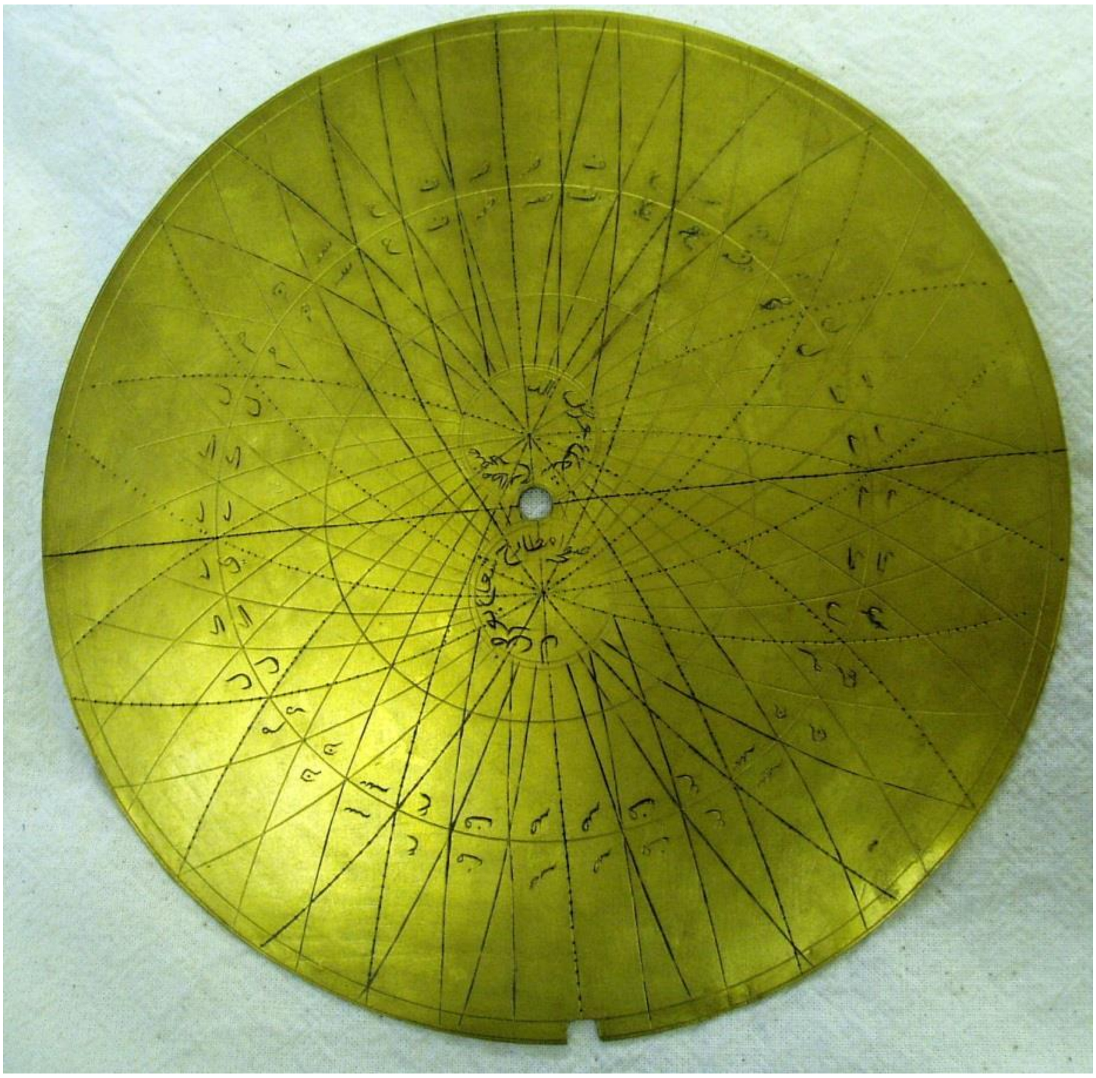

Figure A095.5 – Plate 6b for latitudes 24° and 30° (photo by S. R. Sarma)

Plate 6b carries double projections for latitudes 24° and 30° and shows the 12 astrological houses at both these latitudes. Each house is divided into 10°. These divisions are numbered, separately for each latitude, along the circle of equator as 10—90; 90—10; 10—90; 90—10. Around the centre in the upper half there is a label which reads *ṣafīḥat maṭāraḥ shuᶜāᶜ bi-ᶜarḍ 24* (plate for finding the astrological rays at latitude 24) and in the lower half *ṣafīḥat maṭāraḥ shuᶜāᶜ bi-ᶜarḍ 30* (plate for finding the astrological rays at latitude 30).

GEOGRAPHICAL GAZETTEER

On the inner surface of the mater, a geographical gazetteer is engraved in four concentric circles with the names, longitudes and latitudes of 119 localities, arranged in the order of climates. However, after mentioning three places which lie beyond the

seventh climate, the gazetteer adds 22 more names of places belonging mainly to India. Such additions are to be found in several gazetteers of Ḍiyā’ al-Dīn.

Figure A095.6 – Geographical Gazetteer (photo by S. R. Sarma)

In the Lahore astrolabes, great care is taken to engrave the gazetteers in different artistic patterns. Such care is not seen in this astrolabe. The circles separating the rows and the lines separating the columns are not engraved to the same depth as the entries themselves, with the result that the data looks much cluttered, as in Ḍiyā’s astrolabe of 1650 (A064) in the Brooklyn Museum. These two gazetteers may have been engraved by some assistants of Ḍiyā’ al-Dīn and not by himself.

Table A095-3 Geographical Gazetteer

	Place Names	L	φ
	First Circle		
[-I] *az khaṭṭ istiwā tā iqlīm awwal* (from the line of equator up to the first climate)			
1	Sāhil Baḥr Awqiyānūs	6;0	0;0
2	Jazīra Qanbula	21;0	3;0
3	Jamkūt	187;0	5;0
4	Thalā	189;0	5;0
5	Kūhkū	54;10	10;10
6	ᶜAdan	76;0	11;0
[I] *iqlīm awwal* (first climate)			
7	Jabal	75;0	13;30
8	Damār	77;15	13;30
9	Bajja Barbar	10;0	14;0
10	Dabīl	74;20	14;10
11	Ṣanᶜāʾ Dār al-Mulk Yaman	77;30	14;30
12	Sawmnāt	107;0	17;0
13	Mandū	107;13	22;13
14	Bījāpūr	105;30	17;20
15	Burhānpūr	113;0	20;30
16	Dawlatābād	111;0	20;30
[II] *iqlīm dūyam* (second climate)			
17	Jadda	76;0	21;0
18	Ṭāᶜif	77;30	21;20

	Place Names	L	φ
19	Makkā Mu^caẓẓama	77;10	21;40
20	Khanbayāt	109;20	22;20
21	Madīnah	75;20	25;0
22	Ajmīr	111.5	26;0
23	Qannawj	115;50	26;35
24	Jawnpūr	119;6	26;36
25	Akbarābād	114;0	26;43
26	Kara [wa] Mānikpūr	118;10	26;49
27	Awadh	118;6	27;22
28	Kawāliyār	119;0	26;29
[III] *iqlīm sīwum* (third climate)			
29	Kūl [wa] Jalālī	114;19	28;6
30	Fīrūzābād	106;30	28;7
31	Sultānkūt	115;0	28;30
32	Shāhjahānābād	113;35	28;39
33	Pānīpat	113;20	28;30
34	Hānsī	112;25	29;45
35	Multān	107;35	29;40
36	Iskandariya	61;54	30;18
37	Miṣr	68;20	30;20
38	Sunām	112;25	31;30
39	Kufa	79;30	31;30
40	Bayt al-Maqdis	66;30	31;50
41	Lāhūr	109;20	31;50

	Place Names	L	φ
42	Yazd	89;0	32;0
43	Iṣfahān	87;40	32;0
44	Qandahār	87;40	33;0
45	Siyālkūt	89;20	33;0
46	Baghdād	82;0 !	33;35
47	Dimashq	70;0	33;0
	Second Circle		
[IV] *iqlīm chahārum* (fourth climate)			
48	Ṭarābulus	69;40	34;0
49	ᶜĀna	76;0	34;0
50	Kāshān	86;0	34;0
51	Mawṣil	77;0	34;30
52	Harāt	94;30	34;30
53	Kābul	104;40	34;30
54	Qumm	85;40	34;45
55	Rayy	86;20	35;20
56	Sāwa	85;0	35;0
57	Kashmīr	108;0	35;0
58	Mashhad Maqdis	92;30	36;0
59	Balkh	101;0	36;0
60	Qazwīn	85;0	35;55
61	Badakhshān	84;24	37;10
62	Ṭāliqān	81;45	36;10
63	Sabzawār	91;30	34;5

	Place Names	L	φ
64	Ḥalab	72;10	35;50
66	Tūn	92;30	37;30
67	Sarakhsh	94;30	37;30
68	Marw	97;0	37;40
69	Tabrīz	82;0	38;0
70	Ardabīl	80;0	38;0
71	Nakhjawān	81;15	38;40
72	Bisṭām	89;30	36;0
[V] *iqlīm panjum* (fifth climate)			
73	Samarqand	99;36	39;37
74	Bukhārā	97;30	39;50
75	Tubbat	110;0	40;0
76	Barda[c]	83;0	40;30
77	Samākhī	84;30	40;50
78	Qūnyia	66;30	41;0
	Third Circle		
tatimma iqlīm panjum (continuation of fifth climate)			
79	Khujand	85;35	41;55
80	Khutan	107;0	42;0
81	Kāshān	101;35	42;0
82	Farghāna	102;0	42;20
[VI] *iqlīm shashum* (sixth climate)			
83	Kashghar	106;30	44;0
84	Bandqīya	92;0	44;0

	Place Names	L	φ
85	Shalkh	85;30	44;0
86	Ṭarāna ?	99;50	44;31
87	Pīsh Bāligh	111;0	44;50
88	Qarāqūrūm	115;0	46;0
89	Khān Bāligh	81;34!	46;0
90	Harqala	67;20	46;30
[VII] *iqlīm haftum* (seventh climate)			
91	Araq	105;0	48;0
92	Bulghār	95;0	49;30
93	Aqjākirmān	92;0	50;0
94	Qirqir	65;10	50;0
[VII+] *khāriz* (beyond [the seventh climate])			
95	Jazā’ir Rūdjard	68;50	60;0
96	Kirmān Mārī	65;45	50;45
97	Ṣūdāq	66;0	51;0
iqlīm ba^{c}ah (?)[475]			
98	Munkīr	121;45	26;40
99	Ilāhābād	115;34	26;50
100	Sūrat	108;50	20;15
101	Kūrakhpūr	119;15	27;20
	Fourth Circle		

475 I do not understand the superscript. The 22 places that follow are mainly from India and should have been included in the respective climates. The gazetteer in Ḍiyā’s astrolabe of 1663 (A082) also has an addenda of 15 places, many of which are included here.

	Place Names	L	φ
102	Sarandīb	104;0	10;0
103	Bānāras	117;20	26;52
104	Dhākā Bankāla	130;0	27;0
105	Sonār Kānv	131;0	26;0
106	Bharūj	111;0	21;20
107	Sirhind	111;33	30;30
108	Patna	120;45	26;40
109	Rahtās	119;45	26;30
110	Janad	75;30	14;30
111	Zaytūn	114;0	17;15
112	Hurmūz	92;0	25;0
113	Lakhnawtī	114;33	26;30
114	Kūpāmāū	116;33	26;45
115	Badā’ūn	119;39	27;34
116	Kūlkanda	114;19	18;0
117	Bakar[476]	105;0	24;40
118	Baran	114;	28;43
119	Khaybar	75;20	25;20

[476] This and the next two places are engraved inside the fourth circle.

Figure A095.7 – Back of the astrolabe (photo by S. R. Sarma)

BACK

On the back, the degree scale on the rim is much wider than the scale on the limb in the front. The upper half of this scale, meant for measuring the latitude, is divided in 1°, 2° and 6° and labelled as 6—90; 90—6.

In the upper left quadrant is a sexagesimal sine-cosine graph with very finely drawn 60 horizontal parallels and 60 vertical parallels, where each sixth line is highlighted with dots. There are also engraved semi-circles on both the radii to determining the versed sines, 3 quarter circles around the centre at 24 units (the arc of the obliquity of the ecliptic), 12 units (?) and 8 units (?). There is a radial line joining the centre to 45° on the arc and another line joining the inner terminals of the arc.

In the upper right quadrant are drawn declination arcs for each 10° of solar longitude; those representing 30° and thus forming the boundaries between two successive signs are dotted. The names of the corresponding signs are engraved along the two radii; and their subdivisions are numbered in lines parallel to the names of the signs. On this quadrant are drawn dotted arcs of unequal hours, which are numbered from 1 to 6 in anti-clockwise direction and 7 to 12 in the reverse direction. There are also drawn 6 sigmoid curves to show the midday altitude of the sun throughout the year at 6 different latitudes, viz. 21° (Mecca), 24° (Tropic of Cancer), 27° (Agra), 29° (Delhi), 32° (Lahore), 36°(middle of the fourth climate, i.e., the middle of the inhabited world). These show the relation between the sun’s right ascension and the meridian altitude. Only the lowermost curve is accompanied by a full label which reads *khaṭṭ niṣf al-nahār bi-ᶜarḍ 36*. For other curves just the latitude is mentioned *ᶜarḍ 21, ᶜarḍ 24* and so on.

In the lower half are drawn the shadow squares, on the left a gnomon of 12 digits as well as of 60 divisions, on the right for a gnomon of 7 feet. The vertical and horizontal scales on the left are divided into 12 units and numbered from 1 to 12. Each unit is further subdivided into 5 divisions. The vertical scale carries the label *ẓill sattaynī aṣābiᶜ maᶜkūs* (reverse shadows of sexagesimal divisions and [twelve] digits) and the horizontal scale *ẓill sattaynī aṣābiᶜ mustawī* (direct shadows of sexagesimal divisions and [twelve] digits). The vertical and horizontal scales on the right are each divided into 7 units each and are numbered from 1 to 7. Here the vertical scale is accompanied by the label *ẓill aqdām maᶜkūs* (reverse shadows in feet) and the horizontal scale *ẓill aqdām mustawī* (direct shadows in feet).

These shadow squares enclose two rectangular tables. The upper one carries the heading *jadwal arbāb muthallathāt nahārī wa laylī* (table of the regents of the triplicities,

diurnal and nocturnal) and consists of four sub-tables related to the four elements: *nārī* (fiery), *tarābī* (earthy), *hawā’ī* (airy) and *māhī* (watery).

Below this there is a table giving the multiples of difference between the correct length of the year and 365 days. This is table is called *faḍl al-dawr* (excess of revolution). The heading appears to be engraved on the right, but it cannot be read clearly. The multiples given are for each number from 1 to 9 and then for tens from 10 to 90.

The rim of the lower half is engraved with cotangent scales in the outer semi-circular row and their subdivisions in the inner row.

Next two rows are engraved with names of the 12 signs of the zodiac and the names of the 28 corresponding lunar mansions respectively. These are followed by two rows containing the table of the limits of the signs (*al-ḥudūd*) while the last two rows carry the table of faces (*al-wujūh*).

ALIDADE

The alidade has ornate ends and an ornate centre-piece. It carries in the upper register on the right hand side a sexagesimal scale to match with the divisions in the upper left quadrant. In the lower register on the same side is a scale of unequal hours to be used when the alidade is employed as a sundial with the sighting plate on the right as the gnomon. The left hand side of the alidade is marked with a zodiac scale and the serial numbers of the signs to match the divisions in the upper right quadrant.

A096⊙ ASTROLABE ATTRIBUTABLE TO ḌIYĀ’ AL-DĪN MUḤAMMAD[477]

Not dated, 17th century

Diameter 140 mm

Chicago, Adler Planetarium (#N 68)

CCA 2604

Figure A096.1 – Front of the Astrolabe
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

[477] Entry based on Pingree 2009, No. 33, pp. 154-159; the star list has been rearranged according to increasing right ascension.

This elegantly made astrolabe is not signed nor dated. Pingree assigns it to 18th century, without mentioning any reason. But on the basis of the large number of sigmoid curves for the midday altitude of the sun engraved on its back, it can safely be attributed to Ḍiyā’ al-Dīn of the seventeenth century. The geographical gazetteer of this astrolabe is arranged according to climates in the same manner as some of the astrolabes by Ḍiyā’ al-Dīn. All the latitude plates carry lines for *ghaṭīs*, in addition to the usual lines of seasonal hours and equal hours. The maximum duration of the daylight is mentioned both in hours and in *ghaṭīs.*

COMPONENTS

Body with *kursī* (d. 140, h. 185, t. 7.5), shackle and ring, rete for 41 stars, 7 plates, alidade with sighting tube, 2 washers, pin and horse.

FRONT

The ring is plain; the shackle is trifoliate. The *kursī* elegantly reticulated with a large flower in the middle and two tulips with flared petals on either side, with their tendrils overlapping each other. The profiles are made up of ogees at the base and top with two lobes in between, a trifoliate finial at the top. The limb is graduated for 0.30°, 1° and 5° and labelled in 5s from 5 to 360.

Figure A096.2 – Rete of the astrolabe
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

RETE

The peripheral Capricorn ring and the broad ecliptic ring are held together by the equinoctial bar which has counter changes at its two intersections with the ecliptic ring. The ecliptic ring is divided into the 12 signs of zodiac and labelled with their names. Each sign is divided into groups of 6° and numbered from 6 to 30. The edge of the ecliptic ring is divided in 3° and 1°. The star pointers are joined by nearly symmetrical floral tracery.

Table A096-1 Stars on the Rete

	Star Names	Identification
1	*Dhanab a-Qayṭus*	β Ceti
2	*Baṭn al-Ḥūt*	β Andromedae
3	*Rijl Musalsala*	γ Andromedae
4	*Fam Qayṭus*	γ Ceti
5	*Ṣadr al-Qayṭus*	π Ceti
6	*Rās al-Ghūl*	β Persei
7	*Kaff al-Jadhmā’*	α Ceti
8	*Tālī Masāfat al-Nahr*	γ Eridani
9	*ᶜAyn al-Thawr*	α Tauri
10	*ᶜAyyūq*	α Aurigae
11	*Rijl Jawzā’ Yusrā*	β Orionis
12	*Yad al-Jawzā’ al-Yusrā*	γ Orionis
13	*Yad al-Jawzā’ al-Yumnā*	α Orionis
14	*Rijl Jawzā’ Yumnā*	κ Orionis
15	*Shiᶜrā Yamānī*	α Canis Majoris
16	*Shiᶜrā Shāmī*	α Canis Minoris
17	*Fard al-Shujāᶜ*	α Hydrae
18	*Ẓahr Dubb al-Akbar*	α Ursae Majoris
19	*Qāᶜidāt al-Bāṭiya*	α Crateris
20	*ᶜAnāk*	ζ Ursae Majoris
21	*Janāḥ al-Ghurāb*	γ Corvi
22	*Aᶜzal*	α Virginis
23	*Simāk Rāmiḥ*	α Bootis
24	*Fakka*	α Coronae Borealis

	Star Names	Identification
25	*ᶜUnuq al-Ḥayyah*	α Serpentis
26	*Minkhār* (?) *Muqaddim*	ρ Serpentis ?
27	*Al-Jathī*	α Herculis
28	*Rās al-Ḥawwā’*	α Ophiuchi
29	*ᶜAyn al-Tinnīn*	α Draconis
30	*Rukbat al-Ḥawwā’ Yusrā*	ζ Ophiuchi
31	*Nasr Wāqiᶜ*	α Lyrae
32	*Minqār Dajāja*	β Cygni
33	*Nasr Ṭā’ir*	α Aquilae
34	*Dhanab Dulphīn*	ε Delphini
35	*Fam Faras*	ε Pegasi
36	*Dhanab al-Jadī*	δ Capricorni
37	*Sāq Sākib al-Mā’*	δ Aquarii
38	*Dhanab al-Qayṭus*	ι Ceti
39	*Mankib Faras*	β Pegasi
40	*Surrat Faras*	δ Pegasi
41	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are seven plates. The first five carry altitude circles for every 1° with each third highlighted with dots. These are numbered in 3s and 6s on both sides. On these plates, azimuth arcs are drawn for every 10° below the horizon and numbered. Lines for seasonal hours are drawn and numbered from the western horizons. Dotted lines for equal hours and equal *ghaṭīs* are also drawn, but there is variation. On plates 1b, 3b, 4a, 4b, 5a, 5b these are drawn from the western horizon and the *ghaṭīs* are numbered from 1 to 30 from the western horizon along the equator. On the remaining plates, viz., 1a,

2a, 2b, 3a, the dotted lines for equal hours and equal *ghaṭīs* are drawn both from the western and eastern horizons. Accordingly the *ghaṭīs* are numbered 1 to 15 from the western horizon up to the meridian and again from 1 to 15 from the western horizon up to the meridian. Moreover, on all plate faces are engraved the numerical value of the latitudes, and the maximum duration of daylight both in hours and *ghaṭīs* (engraved as *karhā*). In two cases, the *ghaṭī* values are not correctly calculated.

Table A096-2 Plates

	φ	**Maximum Duration of Daylight** *in hours*	*in ghaṭīs*	*ghaṭīs correct value*
1a	19°	13;11	32;58	32;57,30
2a	21°	13;21	33;22	33;22,30
3a	23;30°	13;24	33;30	33;30
2b	25°	13;25	33;34	33;32,30
4a	27°	13;46	34;25	34;25
5a	30°	13;58	34;55	34;55
4b	32°	14;8	35;8	35;20
5b	35°	14;21	35;52,30	35;52,30
3b	38°	14;50	37;11	37;05
1b	40°	14;54	37;15	37;15
6a	Tablet of ecliptic coordinates			
6b	Tablet of horizons			
7a	0°+44°			
7b	12°+72°			

Plate 6 is engraved on one side with the tablet of ecliptic coordinates with the label *ṣafīḥat mīzān al-ᶜankabūt* and on the reverse side with the tablet of horizons with the label *ṣafīḥa āfāqī*.

Plate 7a carries projections for 0° in the upper half with altitude circles for every 2°. Under the straight horizon, there are labels in the east as well as in the west stating *lā ᶜarḍ lah* (there is no latitude). In the two lower quadrants, there are separate projections for latitude 44° with the labels *al-ᶜarḍ 44.* The significance of this latitude eludes us. Plate 7b is engraved with the projections for latitude 72° in the two quadrants on the right; there are labels *al-ᶜarḍ 72* both quadrants. In the two quadrants on the left there are separate projections for latitude 12° with labels to this effect. Again the significance of this latitude eludes us.

Figure A096.3 Geographical gazetteer
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

GEOGRAPHICAL GAZETTEER

The geographical gazetteer provides the names, longitudes and latitudes of 109 places in three circles. The places are arranged according to climates. However, care is not taken arrange the places by increasing latitude within each climate, in particular, in the second climate between nos. 24 and 38. The enumeration begins in the inner circle.

Table A096-3 Geographical Gazetteer

	Place Names *al-bilād*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*	**Identification / Modern name**
	Inner Circle			
[-I] *az khaṭṭ istiwā* (from the line of equator)				
1	Qanbala Jazīra	21;0	3;5	Madagascar
2	Jamkūt	177;0	5;0	Yamakoṭi
3	Shalā	180;0	5;0	(in China)
4	Ghāna	39;0	10;0	Ghana
5	ᶜAdan	76;0	11;0	Aden, Yemen
6	Sarāndīb	130;0	10;0	Sri Lanka
[I] *al-iqlīm awwal* (the first climate)				
7	Bajja az Barbar	65;0	14;0	(in Somalia)
8	Ṣanᶜā’	77;0	14;30	Sana’a, Yemen
9	Jubla	75;0	13;30	Jubil
10	Janad	75;30	14;30	(in Yemen)
11	Sawmnāt	107;0	22;0	Somnath, India
12	Muᶜjam	74;15	17;15	
13	Jurash	77;50	17;15	Jurash, Saudi Arabia
14	Zaytūn	154;0	17;15	Hangzhou, China
15	Bījāpūr	105;30	17;20	Bijapur, India
16	Ṣuhār	84;15	19;20	Sohar, Oman

	Place Names *al-bilād*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*	**Identification / Modern name**
17	Ṭāᶜif	77;30	21;20	Taif, Saudi Arabia
[II] *al-iqlīm al-thānī* (the second climate)				
18	Makka Muᶜaẓẓam	77;10	21;40	Mecca, Saudi Arabia
19	Madīnat Tayyiba	75;20	25;0	Medina, Saudi Arabia
20	Jidda	76;0	21;0	Jeddah, Saudi Arabia
21	Khaybar	75;20	24;20	Khaybar, Saudi Arabia
22	Māhūra	116;0	24;40	Mathura, India
23	Nahlawara	108;20	28;30	Patan, India
	Middle Circle			
tatimma iqlīm al-thānī (continuation of the second climate)				
24	Akbarābād	115;0	26;46	Agra, India
25	Banāras	117;20	26;15	Varanasi, India
26	Kawāliyar	114;0	26;29	Gwalior, India
27	Qannawj	114;50	26;35	Kannauj, India
28	Kara	118;10	26;49	Kara, India
29	Jawnbūr	119;6	26;36	Jaunpur, India
30	Lakhnaw	114;53	26;30	Lucknow, India
31	Badāwān	114;59	27;32	Badaun, India
32	Awadh	118;6	27;22	Ayodhya, India
33	Ajmīr	111;15	26;0	Ajmer, India
34	Kūpāmaw	116;33	26;45	Gopamau, India
35	Burhānbūr	113;0	20;30	Burhanpur, India
36	Dawlatābād	111;0	20;30	Daulatabad, India

	Place Names ***al-bilād***	**L** ***al-ṭūl***	**φ** ***al-ᶜarḍ***	**Identification / Modern name**
37	Aḥmadābād	108;40	23;15	Ahmedabad, India
38	Kanbayāt	109;20	22;20	Cambay, India
[III] *al-iqlīm al-thālith* (the third climate)				
39	Qayrawān	41;0	31;40	Kairouan, Tunisia
40	Maḥdiyya	42;0	32;31	Mahdia, Tunisia
41	Bayt al-Maqdis	66;30	31;50	Jerusalem, Israel
42	Dimashq	70;0	33;15	Damascus, Syria
43	Baghdād	82;0	33;25	Baghdad, Iraq
44	Kūfa	79;30	31;30	Kufa, Iraq
45	Miṣr	63;0	30;20	Cairo, Eqypt
46	Baṣra	84;0	30;0	Basra,Iraq
47	Yazd	89;0	32;0	Yazd, Iran
48	Madā’in	80;20	33;15	Ctesiphon, Iraq
49	Iṣfahān	87;40	32;25	Esfahan, Iran
50	Shīrāz	88;0	29;30	Shiraz, Iran
51	Fīrūzābād	87;30	28;10	Firuzabad, Iran
52	Kirmān	91;30	30;5	Kerman, Iran
53	Hurmūz	92;0	25;0	Hormoz, Iran
54	Siyālkūt	109;0	33;0	Sialkot, Pakistan
55	Lāhūr	109;20	31;50	Lahore, Pakistan
56	Thānīsar	112;33	30;10	Thanesar, India
57	Sunnām	112;25	30;30	Sunam, India
58	Bānīpathah	113;20	28;52	Panipat, India
59	Hānsī	112;25	29;45	Hansi, India

	Place Names *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*	Identification / Modern name
60	Dihlī	113;35	28;39	Delhi, India
61	Kūl [wa] Jalālī	114;19	28;4	Aligarh and Jalālī, India
62	Kūlkanda	114;9	28;4	Golconda = Hyderabad, India
	Outer Circle			
[IV] *al-iqlīm al-rābiᶜ* (the fourth climate)				
63	Karaj	84;45	34;0	Karaj, Iran
64	Tūn	92;30	34;30	Ferdows, Iran
65	Harāt	94;20	34;30	Herat, Afghanistan
66	Kābul	104;0	34;30	Kabul, Afghanistan
67	Qumm	85;40	34;45	Qom, Iran
68	Rayy	86;20	35;0	Shahr Rey, Iran
69	Sāwa	85;0	36;15	Saveh, Iran
70	Kashmīr	108;0	35;0	Srinagar, India
71	Hamadān	83;0	36;10	Hamadan, Iran
72	Ḥalab	72;10	35;50	Aleppo, Syria
73	Mashhad	92;30	36;0	Mashhad, Iran
74	Iskandariyya	61;54	30;58	Alexandria, Eqypt
75	Balkh	101;0	36;51	Balkh, Afghanistan
76	Nīshābūr	92;30	36;21	Neyshabur, Iran
77	Astarābād	89;35	36;50	Gorgan, Iran
78	Qazwīn	85;0	36;55	Qazvin, Iran
79	Badakhshān	104;24	36;10	Faizabad, Afghanistan
80	Marāgha	82;0	37;20	Maragheh, Iran

	Place Names *al-bilād*	**L** *al-ṭūl*	**φ** *al-ᶜarḍ*	**Identification / Modern name**
81	Marw	97;0	37;40	Mary, Turkmenistan
82	Tabrīz	82;0	38;0	Tabrīz, Iran
83	Nakhjawān	81;15	38;40	Nakichevan, Azerbaijan
[V] *al-iqlīm al-khāmis* (the fifth climate)				
84	Samarqand	99;16	39;37	Samarqand, Uzbekistan
85	Baykand	97;30	39;45	Baykand
86	Bukhārā	97;30	39;50	Bukhara, Uzbekistan
87	Tubbat	110;0	40;0	Tibet (Lhasa)
88	Bardaᶜa	83;0	40;30	Barda
89	Shamākhī	84;30	40;50	Shemakha, Azerbaijan
90	Qūnya	66;30	41;0	Konya, Turkey
91	Khujand	105;35	41;55	Leninabad, Uzbekistan
92	Ḥajāj	84;0	42;0	
93	Khutan	107;0	42;0	Khotan
94	Farghanā	102;0	42;20	Fargana, Uzbekistan
95	Īlāq	99;10	43;20	Angren, Uzbekistan ?
[VI] *al-iqlīm al-sādis* (the sixth climate)				
96	Kashghar	106;30	44;0	Kashghar, China
97	Bindiqiyya	42;0	44;0	Venice, Italy
98	Ṭarāz	99;50	44;31	Dzhambul, Kazakhstan
99	Bīsh Bāligh	111;0	45;50	Pochangtse
100	Khān Bāligh	124;0	46;0	Beijing, China
101	Haraqla	67;20	46;30	Eregli, Turkey

	Place Names *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*	Identification / Modern name
[VII] *al-iqlīm al-sābiᶜ* (the seventh climate)				
102	Araq	105;0	48;0	
103	Akla	108;0	49;0	
104	Bulghār	90;0	49;30	Bulgars
105	Aqjaḥ	62;0	50;0	Belgorod Dnestrovsky
106	Qirqir	65;30	50;0	
[VII+] *khārij iqlīm sābiᶜ* (beyond the seventh climate)				
107	Mārī	65;45	50;40	
108	Rudjard Jazā’ir	62;0	Hebrides	
109	Ṣūdāq	66;0	51;0	Sudak

BACK

On the back the rim of the upper half carries the altitude scales which are divided in 0;30°, 1° and 5° and labelled in 5s as 5—90; 90—5. The upper left quadrant is engraved with 60 horizontal and 60 vertical parallels, forming the sines and cosines for each one part of the Radius. Here each fifth line is emphasized with dots. In the upper right quadrant, declinations arcs are drawn for each 5° of solar longitude. The names of the corresponding zodiac signs are engraved along the two radii, together with the numerical value of the subdivisions of the signs as 6, 12, 18, 24 and 30. In this quadrant there are also curves for the midday altitude of the sun throughout the year at nine different latitudes. This is the highest number of curves to be found in the Lahore astrolabes. Their latitude values are engraved along the arc of the quadrant as 19°, 27°, 32°, 36°, 40°, 44°, 49°, 56° and 60°. Below the curves is the label *khuṭūṭ niṣf al-nahār bi-ᶜurūḍ mawḍūᶜah* (lines of midday at local latitudes).

In the lower half there are shadow squares, on the left for a base of 12 and on the right for a base of 7. The related scales, which are divided and numbered accordingly, are accompanied by the usual labels.

Figure A096.4. – Back of the astrolabe
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

Inside the shadow squares there are two tables; on the left is the table of excess of revolution (*faḍl al-dawr*) for 1, 2, 3 … 9 and 10, 20, 30 … 90 years. Here the engraver made a mistake and engraved 11, 12, 13, 14, 15, 16, 17and 18 in the place of 10, 20, 30, 40, 50, 60, 70 and 80. On the right is the table of the planetary lords of the triplicities arranged according to the four elements.

The rim of the lower half carries the cotangent scales and their subdivisions in two semi-circular rows. Then follow two semi-circular rows with the names of the 12 zodiac signs and those of the 28 lunar mansions, two rows showing the planetary lords of the terms and the last two rows indicating the planetary lords of the decans.

ALIDADE

The alidade has ornate ends and an ornate centre-piece and is equipped with a sighting tube. The right half is engraved with a sexagesimal scale in the upper register and a scale of seasonal hours on the lower register. The left half carries a zodiac scale with the signs marked by their serial numbers.

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Pingree 2009, No. 33, pp. 154-159.

A097 ASTROLABE ATTRIBUTABLE TO ḌIYĀ’ AL-DĪN MUḤAMMAD

Not dated, 17th century

Diameter 202 mm

PLU, ex-Paris, Brieux

Figure A097.1 – Front of the Astrolabe (from the catalogue of Nouveau Drouot)

This astrolabe is not signed, nor dated. But it may be attributed to Ḍiyā’ al-Din because of four sigmoid curves of the midday altitude of the sun engraved on the back and because of the very large number of star pointers on the rete.

COMPONENTS

Body with *kursī* (d. 202, h. 298, t. 16), ring and shackle, rete for 90 stars, 8 plates, alidade, pin and horse.

FRONT

The ring is large and plain and the shackle is trifoliate. The *kursī* is solid with lobed profiles. The degree scale on the limb is divided in 1°, 3° and 6°. The groups of 6° are numbered in *abjad* from 6 to 360 in the outer band, while the groups of 3° are numbered in common Arabic/Persian numerals (not in ‘chiffres indiens’ as the catalogue states) from 3 to 90, separately in each quadrant.

RETE

The Capricorn ring and the ecliptic ring are held together by the floral tracery which joins the star pointers. The equinoctial bar is represented as two small fragments to the east and west of the ecliptic ring and the solstitial bar just inside the ecliptic ring. There are said to be as many as 90 named star pointers. This is the largest number in the Lahore astrolabes. Unfortunately the photos printed in the catalogue do not allow the decipherment of the names.

PLATES

There are said to be 8 plates serving latitudes between 21;40° and 36°, besides the tablet of the ecliptic coordinates and the tablet of horizons. There is said to be also a plate on which the astrological houses are marked. Perhaps this is similar to the plate 6b in astrolabe A095 (Figure A095.5) at the Museum of the History of Science at Oxford.

GEOGRAPHICAL GAZETTEER

A geographical gazetteer with the names, longitudes and latitudes of 127 places is engraved in four circles on the inner side of the mater.

BACK

The rim of the upper half carries the altitude scales which are divided, like the degree scale on the limb, in 1°, 3° and 6°. Also like the degree scale in the front, here also groups of 6° in the outer band are labelled in *abjad* from 6 to 90 as 6—90; 90— 6. The groups of 3° in the middle band are numbered in common Arabic/Persian numerals from 3 to 90 as 3—90; 90—3.

There is a close resemblance between this astrolabe and the astrolabe A095 in the manner in which the four quadrant are designed. The upper left quadrant is engraved with 60 vertical and 60 horizontal parallels, with every sixth highlighted with dots. As in the astrolabe A095, here also are engraved semi-circles on both the radii, 3 quarter circles around the centre at 24 units (the arc of the obliquity of the ecliptic), 12 units (?) and 8 units (?). There is a radial line joining the centre to 45° on the arc and another line joining the inner terminals of the arc.

In the upper right quadrant are drawn declination arcs for each 10° of solar longitude; those representing 30° and thus forming the boundaries between two successive signs are dotted. The names of the corresponding signs are engraved along the two radii; and their subdivisions are numbered in lines parallel to the names of the signs. There are also drawn 4 sigmoid curves to show the midday altitude of the sun throughout the year at 4 different latitudes, viz. 27° (Agra), 29° (Delhi), 32° (Lahore), 36°(middle of the fourth climate, i.e., the middle of the inhabited world). These carry the labels *ᶜarḍ 27, ᶜarḍ 29, ᶜarḍ 32* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ 36°.*

In the lower half, there are shadow squares. On the left is the square for 12 digits and 60 divisions. The vertical and horizontal scales are divided into 12 units each; each unit is again subdivided into 5 divisions. These are numbered in 5s from 5 to 60. The vertical scale is accompanied by the label *ẓill sullam sattaynī aṣābiᶜ maᶜkūs* and the horizontal scale by *ẓill sullam sattaynī aṣābiᶜ mustawī.*

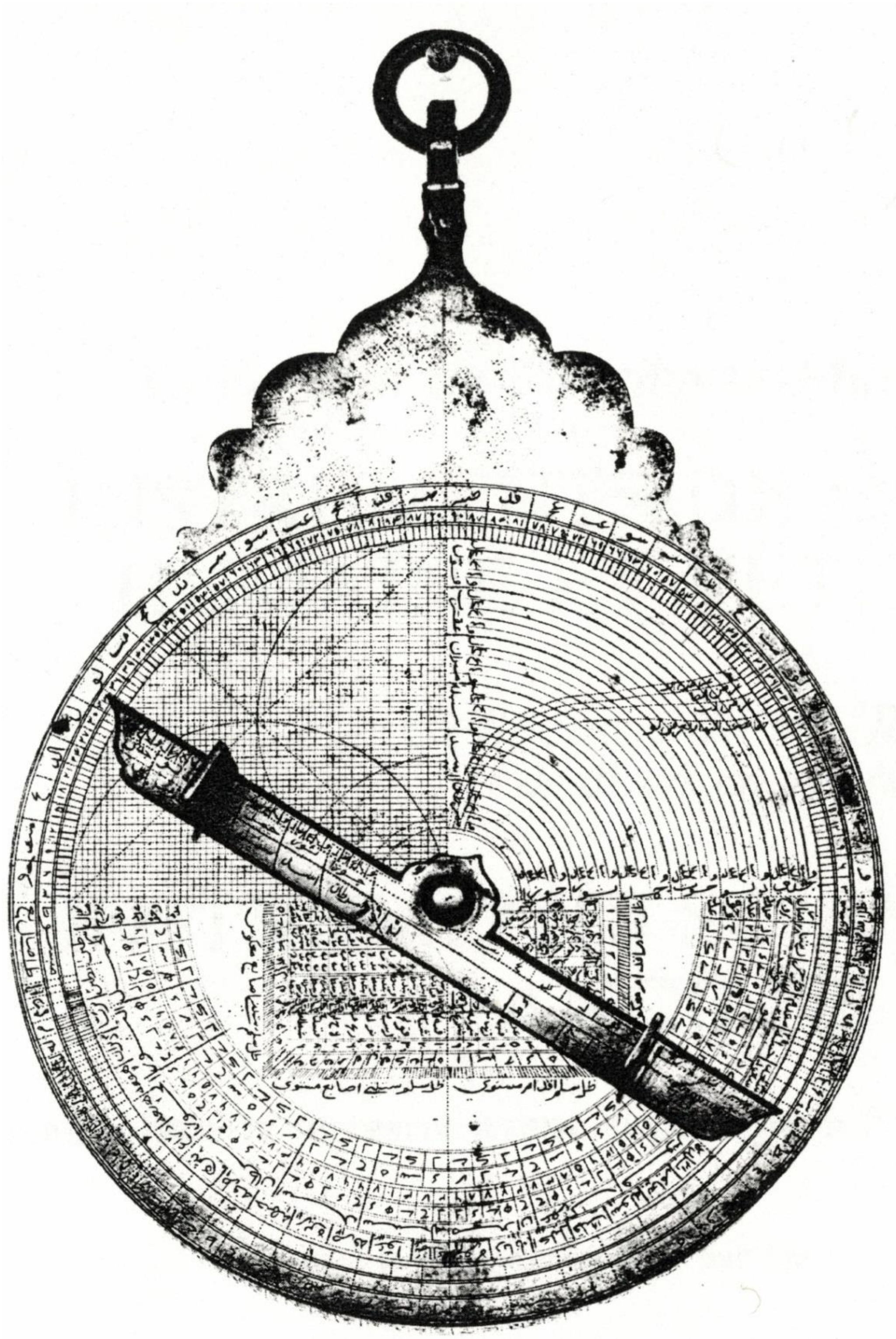

Figure A097.2 – Back of the Astrolabe (from the catalogue of Nouveau Drouot)

On the left is the square for 7 feet. Here the vertical and horizontal scales are divided into 7 units each and numbered from 1 to 7. Then, very unusually, each unit is further subdivided into 7 divisions. The vertical scale is accompanied by the label *ẓill sullam aqdām maᶜkūs* and the horizontal scale by *ẓill sullam aqdām mustawī.*

The shadow squares enclose several astrological tables. It is difficult to identify them in the available photos, especially because a large part is obscured by the alidade.

The rim of the lower half carries the cotangent scales and their subdivisions in three semi-circular rows. These are followed by 6 semi-circular rows. Interestingly, to the left and right of each row is a label stating the contents of the particular row. Thus the first row has the label *manājil* and carries the names of the 28 lunar mansions together with their serial numbers in common Arabic/Persian numerals. The second row has the label *burūj* and has the names of the 12 signs of the zodiac. The third row carries the label *ḥudūd* and carries the last syllables of the names of the five planetary lords governing the five limits of each sign. The fourth row has the label *adad* (number) and displays the numerical value of the five limits of each sign. The fifth row is labelled *wujūh* and has the last syllables of the names of the planetary lords of the decans while the sixth row has the label *adad* (number) and displays the numerical values of the three decans of each sign, viz. 10, 20 and 30.

ALIDADE

The alidade is well crafted with ornate ends and an ornate centre piece. The right arm carries a sexagesimal scale and the scale of unequal hours, while the left arm is engraved with the zodiac scale, the names of the signs and their subdivisions of 6°.

PROVENANCE

Came up for auction at Nouveau Drouot, Paris, on 28 April 1982, lot 82; later included in Alain Brieux’s catalogue of November 1983, no. 14.

BIBLIOGRAPHY

Catalogue of Nouveau Drouot, Paris, on 28 April 1982, lot 82, with the photos of the front and back.

Catalogue of Alain Brieux, Paris, of November 1983, no. 14, p. 32, with the same text as above, but with the photo of the front.

A098 ASTROLABE ATTRIBUTABLE TO ḌIYĀ’ AL-DĪN MUḤAMMAD[478]

Not dated, 17th century

Diameter 80 mm

PLU, ex-London, Sotheby’s (auction 24 October 2007, lot 196)

Figure A098.1 – Front of the astrolabe (© Sotheby’s, London)

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478 Entry based on Sotheby’s auction catalogue of 24 October 2007, lot 196, pp. 186-187.

This astrolabe is neither signed, nor dated, but the finely reticulated *kursī* shows that it is the work of Ḍiyā’ al-Dīn. In particular, the motif of the central flower with three elongated petals and the decorative engraving on the surface occurs in some of the astrolabes signed by Ḍiyā’ al-Dīn (A066, A070 and A071). There are several unusual features in this astrolabe. In the rete, both the equinoctial bar and the ring of the ecliptic are counter-changed at the equinoxes. The Sotheby’s catalogue says that this is ‘a feature not known from any other astrolabe’. But it can be seen in the astrolabe attributable to Qā’im Muḥammad (A014) and in the astrolabe with the *qibla*-indicator made by Ḥāmid in 1686 (A112). The degree scale on the limb is also somewhat unusual. The most unusual feature, however, is the configuration on the back where the lower half contains projections of an astrolabe plate for latitude 27° (Agra). Since special emphasis is given in this manner to Agra, and since in the upper half there are solar meridian altitude curves only for latitudes 27° (Agra) and 32° (Lahore) and not for 29° (Delhi), this astrolabe may have been produced before the Mughal capital was shifted to Delhi in 1648.

Components

Body with *kursī* (d. 80, h. 102), shackle and ring, rete for ca. 25 stars, 5 plates, alidade, pin and horse.

Front

The reticulated *kursī* is elegantly crafted with decorative engravings on the surface on the front and on the back. The finial of the *kursī* is trifoliate, so also the shackle.

The limb carries three registers. The inner register is divided into 1°. The middle one is divided in 5° and labelled clockwise as 5, 10, 5, 20, 5 … 5, 90, separately in each quadrant. The *abjad* symbols are written with their tops oriented towards the centre. In the outer register groups of 15° (= 1 hour) are numbered serially with common Arabic/Persian numerals from 1 to 12: on the right hand side, starting at the south point and proceeding clockwise up to the north point; on the left hand side, starting at the south point and proceeding anti-clockwise up to the north point. This is also an unusual feature, not met with in any Lahore astrolabe.

RETE

As mentioned above, both the equinoctial bar and the ecliptic ring are counter-changed at their two intersections at the equinoxes. The ecliptic ring is divided into the 12 signs of the zodiac and their names from Aries to Virgo are engraved on the outer band of the ring and the names from Libra to Pisces on the inner band. Each sign is divided into units of 6° and the numbers are engraved on the inner band of the ecliptic ring in the lower half and on the outer band in the upper half. This is exactly how it was done also in A014 and in A112.

The star pointers are joined by an almost symmetric floral tracery. The motif of the trifoliate flower in the *kursī* is repeated in the rete also, precisely below the *kursī* on the meridian line. The names of the stars engraved on the pointers are often drastically abridged. The following 25 names are listed in the Sotheby’s catalogue, to which we add the modern identifications.

Table A098-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus*	β Ceti
2	*Ṣadr al-Qayṭus*	π Ceti
3	*Ghūl*	β Persei
4	*[ᶜAyyū]q*	α Aurigae
5	*Tālī Masāfat al-Nahr*	γ Eridani
6	*Rijl al-Yusrā*	β Orionis
7	*Rijl al-Yumnā*	κ Orionis
8	*Yamānī*	α Canis Majoris
9	*Shāmī*	α Canis Minoris
10	*Muqaddam*	α Geminorum
11	*Fard*	α Hydrae
12	*Qalb Asad*	α Leonis
13	*Qā’idat al-Bāṭiya*	α Crateris

	Star Name	Identification
14	*ᶜAnāq*	ζ Ursae Majoris
15	*Ṣarfa*	β Leonis
16	*Fakka*	α Coronae Borealis
17	*Aᶜzal*	α Virginis
18	*Ḥayya*	α Serpentis
19	*Jāthī*	α Herculis
20	*[Wā]qiᶜ*	α Lyrae
21	*Minqār Dajāja*	β Cygni
22	*Ṭā’ir*	α Aquilae
23	*Sāq Sākib al-Mā’ J[anūbī]*	δ Aquarii
24	*Mankib*	β Pegasi
25	*Khaḍīb*	β Cassiopeiae

PLATES

The catalogue does not specify which two sides belong to which plate. Therefore, the ten sides of the five plates are listed below serially. It is not known whether the tenth side contains the tablet of ecliptic coordinates or the tablet of horizons.

Table A098-2 Plates

	φ	Longest Day
1	28°	13;52 hours
2	29°	13;55 hours
3	32°	14;8 hours
4	33°	14;12 hours
5	35°	14;29 hours

	φ	Longest Day
6	37°	14;36 hours
7	39°	14;47 hours
8	32;30°	14;6 ! hours
9	34°	14;17 hours
10	?	

The selection of these latitudes is also unusual; it is incomprehensible which locality is specified by the latitude 32;30°. On these plates, altitude circles are drawn for every 6°. Azimuth arcs are drawn for every 10°; in plates 1 to 7, below the horizon and in others above the horizon.

Lines for seasonal hours are drawn on all plates. Dotted lines for equal hours vary:. On plates 1and 2, these are drawn both from the western and the eastern horizons up to the meridian. On plates 3 to 7, they are drawn from the western horizon. On plates 8 and 9, besides the lines drawn from the western horizon for the equal hours, there are also lines for each 15 minutes.

Geographical Gazetteer

The gazetteer engraved on the inner side of the mater lists 68 localities with their longitudes and latitudes.

Back

On the back, the altitudes scales on the upper half of the rim are divided in 1°, 3° and 6° by dotted lines and labelled in 6s as 6---90; 90---6. In the upper left is the trigonometric quadrant with 30 horizontal parallels, each third dotted. The solar quadrant on the right is divided into 6 zones by declination arcs. The corresponding signs are marked by their serial numbers along the two radii. Two curves for the midday altitude of the sun throughout the years are drawn for latitudes 27° (Agra) and 32° (Lahore) with the labels *ᶜarḍ 27* and *ᶜarḍ 32*.

The shadow squares, instead of being drawn in the lower half, are superimposed on the upper two quadrants, on the left for the base of 7 and on the right for the base of 12 with incomplete labels.

Figure A098.2 – Back of the astrolabe (© Sotheby’s, London)

The lower half the back is the most extraordinary feature of this astrolabe. It is engraved as the left half of a plate for latitude 27° with the altitude circles for each 6°(every third dotted) and with dotted lines for the equal hours before sunrise. Moreover, the circle of ecliptic is drawn along with the names of the 6 signs *al-Saraṭān* to *al-Qaws.* These projections are framed by a degree scale, divided in 2° and 10° and labelled in 10s, from 90 to 10 (from the south point to the east point) and again from 10

to 90 (from the east point to the north point). With this configuration, the standard operations can be performed by means of the alidade as is done on an astrolabe quadrant.

The rim of the lower half contains cotangent scales, on the left for digits and on the right for feet. Inside these scales are two semi-circular rows with the names of the 28 lunar mansions and those of the corresponding 12 zodiac signs.

ALIDADE

The alidade has ornate ends and an ornate centre-piece. The edge of the right hand side carries a sexagesimal scale, divided in 2 and 6 units and numbered in 6s from 6 to 60 from the centre onwards. The left hand side bears a zodiac scale marked with the serial numbers of the signs. In the lower register on the right is a universal scale for seasonal hours when the alidade is used as a sundial. The wedge appears to be horse-shaped.

A099⊙ SHIP ASTROLABE ATTRIBUTABLE TO ḌIYĀ’ AL-DĪN MUḤAMMAD

Not dated, 17th century

Diameter 150 mm

Oxford, Museum of the History of Science (#33796)

CCA 90

Figure A099.1 – Front of the Astrolabe (photo by S. R. Sarma)

This unsigned and undated astrolabe can be attributed to Ḍiyā’ al-Dīn Muḥammad because of the *zawraqī* horizons and masts on the rete and the four sigmoid curves of the midday altitude of the sun on the back. As will be shown below, latitude 29° of Delhi receives special emphasis in this astrolabe. This would indicate that the astrolabe was created after 1648 when the Mughal capital was shifted from Agra to Delhi. Although *zawraqī* horizons for the latitudes of 29° and 36° are incorporated in the rete, no plate was designed for the use with these *zawraqī* horizons. Instead there is a plate calibrated for 29° in the usual manner on which the positions of 40 stars are marked along with their names. A gazetteer of 69 localities is engraved on the inner side of the mater and another gazetteer of 15 places is engraved on the edge of the astrolabe. This too is unusual.

There is a certain affinity between this and the astrolabe A095 because the plates in both astrolabes look as if they are gilded; both contain a plate in which astrological houses are drawn for latitudes, and the maximum duration of the daylight is given as 13 hours or 14 hours for several latitudes.

COMPONENTS

Body with *kursī* (d. 150, h. 180, t. 14), ring and shackle, rete (d. 130) for 46 stars, 8 plates (d. 130), alidade (l. 135), pin and wedge. The rete is heavily corroded, but the other parts are in good condition.

FRONT

It is a heavy instrument, the womb slighting tapering towards the centre. The ring has an octagonal cross-section, but not well formed; two ends are not welded together. The shackle is heavy, diamond cross-section, trifoliate form, with large bases. The reticulated *kursī* looks as if it is truncated at the top; it is very unusual among the *kursīs* in the Lahore astrolabes. But from the truncated top rises a trifoliate finial. Decorative lines are engraved on the surface on both the sides.

The degree scale on the rim is divided in 1° and 6° and numbered in 6s from 6 to 360 clockwise.

RETE

The peripheral Capricorn ring and the ecliptic ring are held together by the equinoctial and solstitial bars, both completely represented, the former with a counter change at its eastern intersection with the ecliptic ring.

The rete is thicker in the middle and tapers towards the periphery. It looks as if coated with a gold-coloured layer, but the layer is peeling off in places because of corrosion. It is difficult to read in many places. There is a handle on the peripheral ring some 36° west of the north point.

The ecliptic ring is divided into the 12 signs of the zodiac, engraved with their names; each sign is subdivided into 5 parts and numbered in 6, 12, 18, … 30.

Figure A099.2 – Rete with *zawraqī* horizons (photo by S. R. Sarma)

As in Ḍiyā’ al-Dīn’s astrolabe of 1663 (A082), in this astrolabe also two mutually intersecting arcs are incorporated at the middle of the rete. While in the former astrolabe

they are shown only inside the ecliptic circle, here they are extended up to the Capricorn ring on either side. Together with the segments of the solstitial bar, they resemble the outlines of ships with their masts. The arc with the convex side to the north is the oblique horizon for latitude 29°. The eastern and western halves of the arc carry the labels *ufq mujassam sharqī bi-ᶜarḍ 29* (eastern solid horizon for latitude 29) and *ufq mujassam gharbī bi-ᶜarḍ 29* (western solid horizon for latitude 29) respectively. The mast corresponding to this arc, i.e., the solstitial bar above the central hole, has the inscription *shaẓiya yatiru zawraq fawq al-ᶜard* (pointer spanning the *zawraqī* horizons above the earth).

The other arc, with the convex side to the south is the oblique horizon for latitude 36°. The two halves of this arc carry the labels *ufq mujassam sharqī bi-ᶜarḍ 36* (eastern solid horizon for latitude 36) and *ufq mujassam gharbī bi- ᶜarḍ 36* (western solid horizon for latitude 36). Its mast, i.e., the solstitial bar below the central hole, bears the label *shaẓiya yatiru zawraq taḥta al-ᶜard* (pointer spanning the *zawraqī* horizons below the earth). The equinoctial bar carries the labels *mastarat tarbī’ sharqī* (eastern perpendicular rule) in the east *mastarat tarbī’ gharbī* (western perpendicular rule) in the west.

Other *zawraqī* astrolabes (like A013, A082 and A093) contain a plate specially designed for use with the *zawraqī* horizons. There is no such plate in this astrolabe. But on the plate for 29°, the positions of the same stars are marked for which there are pointers on the rete. These star pointers, as Gunther remarks, ‘are quite unlike those of any other astrolabes’ of the Lahore family. In his effort to incorporate the *zawraqī* horizons and their masts, the astrolabe maker did not pay much attention to the star pointers and joined them to the various arcs and to the solstitial bar by indifferent extensions.

PLATES

There are eight plates with the following functions. Some are heavier than the others.

Table A099-1 Plates

	φ	longest day
1a	18°	13 hours!
1b	21°	13 hours!
2a	20°	13 hours!
2b	22°	13 hours!
3a	24°	13 hours!
3b	26°	13 hours!
4a	27°	13 hours!
4b	32°	14;8 hours
5a	34°	14 hours!
5b	38°	14 hours!
6a	Tablet of ecliptic coordinates with the label *ṣafīḥat mīzān al-ᶜankabūt*	
6b	Tablet of horizons with the label *ṣafīḥa āfāqī*	
7a	0°+72°+90°	
7b	29°+32° with astrological houses	
8a	29° with many star positions	13 hours!
8b	36°	14 hours!

The maximum duration of the daylight for the latitude of Lahore at 32° given correctly as 14;8 hours. For other latitudes, it is given either as 13 hours or as 14 hours, which is indeed very strange.

On these plates, as in A095, the lines are well drawn. They look as if drawn with black ink on bright golden background. Likewise the unusual plate 7a has a parallel in A095.

On plates 1-5, altitude circles are drawn for every 3° and labelled on both sides; every fifth of these is dotted. Azimuth arcs are traced for every 10° below the horizon. For every 30°, they are drawn above and below the horizon, with the lower part dotted. There are lines for seasonal hours and lines of equal hours drawn from the western horizon. Both sets are numbered from the western horizon.

Plate 4 for the two imperial cities of Agra (27°) and Lahore (32°) is heavy. 4a for 27° carries projections as above, but 4b made for 32° carries equal *ghaṭī* lines. In order to make space for these below the horizon, azimuth arcs for every 10° are drawn above the horizon. Those for 30° are extended below the horizon as well, but as dotted lines. Equal hour lines are drawn from the western horizon as dotted lines and numbered in *abjad* system. Equal *ghaṭī* lines are also drawn from the western horizon, but as plain lines and numbered in common Arabic/Persian numerals from 1 to 35.

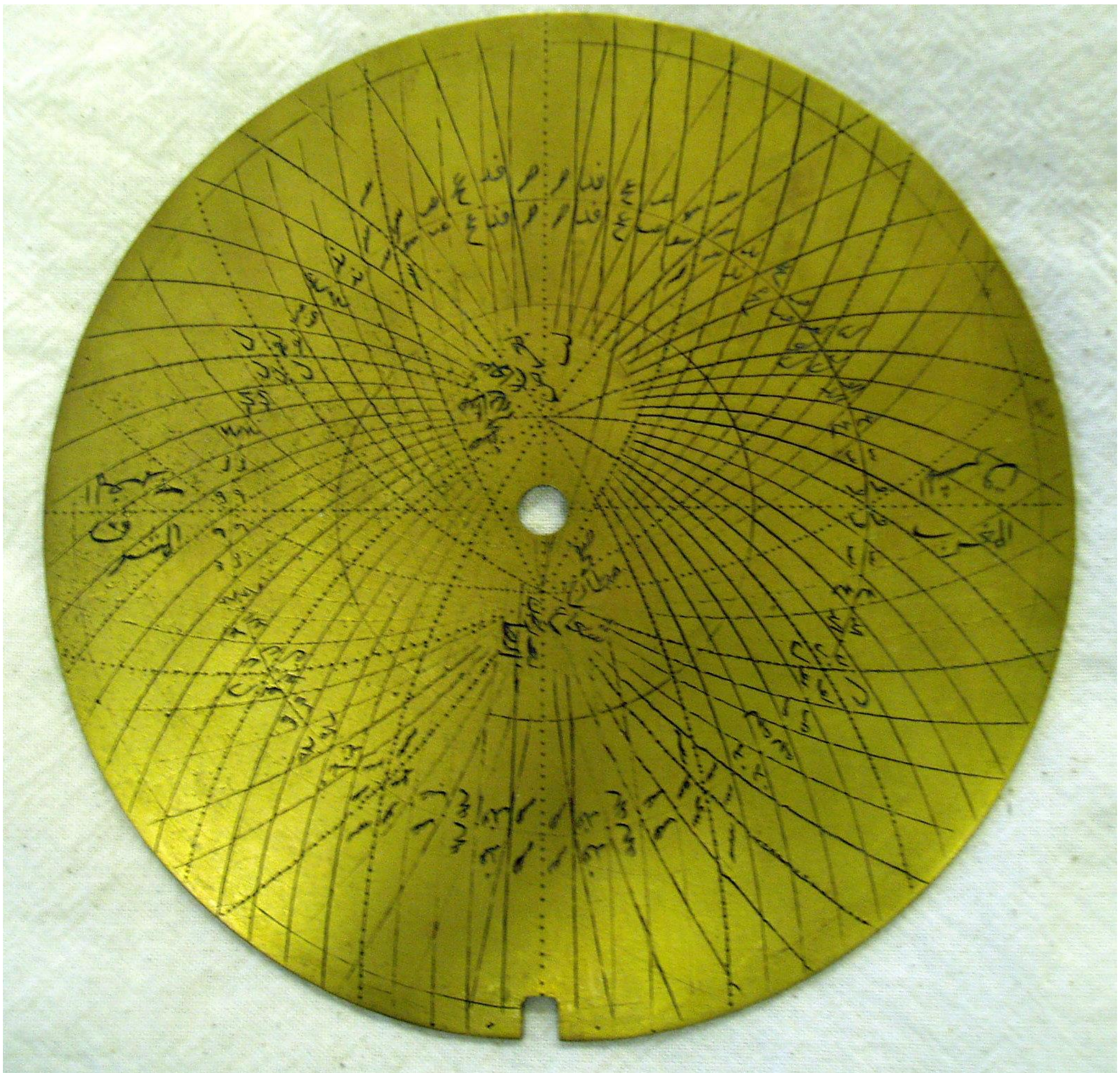

Figure A099.3 – Plate for 32° and 29° with astrological houses (photo by S. R. Sarma)

Plate 7b

The upper half is devoted to latitude 32° and carries the label *safīḥah muṭāraḥ sha^{c}ā^{c} bi-^{c}arḍ 32* and the lower part is devoted to 29° and carries the label *safīḥah muṭāraḥ sha^{c}ā^{c} bi-^{c}arḍ 32* (in A095, it is for 24° and 30°). The astrological houses are drawn for both the latitudes and each house divided in 6°.

Figure A099.4 – Plate for 29° with star positions (photo by S. R. Sarma)

Plate 8a

The plate is heavier than the others, slightly tapering towards the periphery. It is calibrated for latitude 29°. Altitude circles are drawn for every 3° and labelled on both sides of the meridian. Azimuth arcs are drawn at intervals of 10° below the horizon and at intervals of 30° above the horizon. There are lines for seasonal hours, numbered from

the western horizon onwards. Dotted lines for equal hours are drawn from the western horizon and numbered from there.

Superimposed on these projections is the ecliptic ring which is divided into the 12 zodiac signs and labelled with their names. Each sign is divided into groups of 6° and numbered 6, 12, 18, … 30, and again into units of 2°.

Finally positions of 46 stars are marked with dots enclosed in circles. These marks appear to have been punched and not engraved. Six of these are without names. The remaining 40 are accompanied by their names. A juxtaposition of the rete and this plate (see Figure A099.1 above) shows that the stars marked on this plate are the same as those marked on the rete. The names of the 40 named stars are tabulated below, as usual, in the order of increasing right ascension.[479]

Table A099-2 Stars on Plate 8a

	Star Name	Identification
1	*Dhanab al-Qayṭus Sh[amālī]*[480]	ι Ceti
2	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
3	*Ṣadr al-Qayṭus*	π Ceti
4	*Tālī Masāfat al-Nahr*	γ Eridani
5	*ᶜAyn al-Thawr*	α Tauri
6	*ᶜAyyūq*	α Aurigae
7	*Rijl Yumnā*[481]	κ Orionis
8	*Yad Yumnā*	α Orionis
9	*Rijl Yusrā*	β Orionis

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479 This plate shows close resemblance to the back of an astrolabe by ᶜUmar ibn Dawlatshāh ibn Muḥammad al-Kirmānī in 726 AH (AD 1325-26); see Linton 1980; no. 163, pp. 90-91; see also King 2005, p. 57, Fig. 5.1.3.

480 This star should in the northern hemisphere.

481 The sequence of these four stars in Orion is not correct.

	Star Name	Identification
10	*Yad Yusrā*	γ Orionis
11	*Shiᶜrā Yamānī*	α Canis Majoris
12	*Shiᶜrā Shāmī*	α Canis Minoris
13	*Ṭarfat al-Safīna*	ρ Puppis
14	*Minkhir Shujāᶜ*	σ Hydrae
15	*Fard al-Shujāᶜ*	α Hydrae
16	*Qāᶜidat al-Bāṭiya*	α Crateris
17	*Ṣarfa*	β Leonis
18	*Janaḥ al-Ghurāb*	γ Corvi
19	*Simāk Aᶜzal*	α Virginis
20	*ᶜAnāq*	ζ Ursae Majoris
21	*Simāk Rāmiḥ*	α Bootis
22	*Fakka*	α Coronae Borealis
23	*ᶜUnuq al-Ḥayya*	α Serpentis
24	*Qalb al-ᶜAqrab*	α Scorpii
25	*Rukbat Yusrā*	ζ Ophiuchi
26	*Jāthī*	α Herculis
27	*Al-Ḥawwā’*	α Ophiuchi
28	*Tinnīn*	γ Draconis
29	*Yad al-Muqaddam*	α Ophiuchi
30	*Nasr Wāqiᶜ*	α Lyrae
31	*Minqār al-Dajāja*	β Cygni
32	*Nasr Ṭā’ir*	α Aquilae
33	*Dhanab al-Dulfīn*	ε Delphini

	Star Name	Identification
34	*Dhanab al-Dajāja*	α Cygni
35	*Dhanb al-Jadī*	δ Capricorni
36	*Fam al-Faras*	ε Pegasi
37	*Sāk Sākib al-Mā’ J[anūbī]*	δ Aquarii
38	*Mankib al-Faras*	β Pegasi
39	*Surrat al-Faras*	δ Pegasi
40	*Kaff al-Khaḍīb*	β Cassiopeiae

GEOGRAPHICAL GAZETTEERS

There are two geographical gazetteers in this astrolabe. A larger one of 69 localities is engraved on the inner side of the mater in three circles, with the tops of the letters oriented towards the centre. A second gazetteer of 15 localities is engraved on the 14 mm wide edge of the astrolabe, starting from the top on the left and going up to the top on the right. Here the entries are in single file, the place name, longitude and latitude written one below the other. Apparently the second one was also engraved by the same person who took care to see that the length of each entry on the edge coincides with the 6° division on the rim, as can be seen in the photo below. But four places are repeated in the second gazetteer; these are marked with an asterisk*.

Figure A099.5 – The two geographical gazetteers, the first on the inner side of the mater and the second on the edge (photo by S. R. Sarma)

Table A099-3 Geographical Gazetteer

	Place Names *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*
	First circle		
1	Qayrawān	41;0	31;40
2	Miṣr	63;20	30;20
3	ᶜAdan	76;0	11;0
4	Madinat Ṭayyiba	75;20	25;0
5	Tā’īf	77;10	21;40
6	Bayt al-Maqdis	66;30	31;50
7	Dimashq	70;0	33;15
8	Ḥalab	72;10	35;50
9	Mawṣil	77;0	34;30

	Place Names *al-bilād*	**L** *al-ṭūl*	**φ** *al-ʿarḍ*	
10	Nakhjawān	81;15	38;40	
11	Marāgha	82;0	37;20	
12	Tabrīz	82;0	38;0	
13	Bardaʿa*	83;0	41;30	(also 77)
14	Kūfa	79;30	31;30	
15	Baghdād	80;0	33;25	
16	Baṣra	84;0	30;0	
17	Fīrūzābād	87;30	28;10	
18	Shīrāz	88;0	29;16	
19	Yazd	89;0	32;0	
20	Qazwīn	85;0	36;0	
21	Iṣfahān	86;40	32;25	
22	Kāshān	86;0	34;0	
23	Qumm*	85;40	34;45	(also 84)
24	Rayy	86;20	35;0	
25	Astarābād	89;35	36;50	
26	Biṣṭām	89;30	36;10	
27	Mashhad	92;30	36;00	
28	Tūn	92;30	34;30	
29	Herāt	94;20	34;30	
30	Marw	97;00	37;40	
31	Balkh	101;0	36;41	
	Second Circle			
32	Badakhshān	104;24	37;10	

	Place Names *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*	
33	Bukhārā*	97;30	39;50	(also 76)
34	Samarqand*	99;19	39;37	(also 74)
35	Khujand	100;35	41;55	
36	Kāshghar	106;30	44;0	
37	Khutan	107;0	42;0	
38	Hurmūz	92;0	25;0	
39	Kirmān	91;30	30;5	
40	Ghazna	104;20	38;35	
41	Kābul	104;40	34;30	
42	Tubbat	110;0	40;0	
43	Kashmīr	108;0	35;0	
44	Tatah	102;30	25;10	
45	Bakar	105;0	27;40	
46	Qandahār	107;40	33;0	
47	Multān	107;35	29;40	
48	Lāhūr	109;20	31;50	
49	Sialkūt	109;0	33;0	
50	Pānīpatah	113;20	28;52	
51	Tānīsar	112;33	30;10	
52	Haḍrat Dihlī	113;35	28;39	
53	Akbarābād	115;0	26;43	
54	Qannawj	115;50	26;35	
	Third Circle			
55	Banāras	117;20	26;55	

	Place Names *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*	
56	Kawāliyār	115;0	36;29	
57	Jawnpūr	119;6	26;36	
58	Jadda	77;0	21;0	
59	Ujjayn	110;50	23;30	
60	Ajmīr	111;5	26;0	
61	Sarūj	72;40	34;50	
62	Ahmadābād	108;40	23;15	
63	Burhānpūr	103;0	20;30	
64	Bījāpūr	105;30	16;20	
65	Dawlatābād	111;0	20;30	
66	Kūlkanda	114;19	17;04	
67	Sarāndīb	130;0	10;0	
68	Kanbayāt	109;4	22;20	
69	Jamkūt	blank	blank	
	On the Edge			
70	Farghāniya	102;0	42;0	
71	Bāb al-Abwāb	85;0	43;0	
72	Ailāq	99;10	43;20	
73	Shalkh	85;30	44;0	
74	Samarqand*	99;19	39;37	(also 34)
75	Baykand	97;30	39;45	
76	Bukhārā*	97;30	39;50	(also 33)
77	Bardaᶜa*	83;0	40;30	(also 13with φ 41;30)

	Place Names *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*	
78	Samākhī	84;30	40;50	
79	?	104;0	42;0	
80	Khān Bāligh	124;0	46;0	
81	Pīsh Bāligh	111;0	45;50	
82	Harqala	66;20	46;30	
83	Bulghār	90;0	49;30	
84	Qumm*	85;40	34;45	(also 23)

Figure A099.6 – The second gazetteer on the edge, showing the last two entries on Bughār and Qumm, and also the well-formed horse and the trifoliate shackle (photo by S. R. Sarma)

BACK

On the back the upper half of the rim carries the altitude scales which are divided in 1° and 6° and numbered in 6s as 6—90; 90—6.

Figure A099.7 – Back of the Astrolabe (photo by S. R. Sarma)

A sine-cosine graph is engraved in the upper left quadrant with 60 horizontal and 60 vertical parallels with each fifth highlighted with dots. In the upper right quadrant are drawn declination arcs for each sign or 30° of solar longitude. The names of the corresponding signs are engraved along the two radii. Here are also plotted four sigmoid

curves for the midday altitude of the sun at latitudes 24°, 29°, 32° and 36°. As in the preceding three astrolabes (A095, A096, A097), here also the lower-most curve is endowed with a full label *khaṭṭ niṣf al-nahār bi-ᶜarḍ 36.* The other three carry just the latitude values, viz., *ᶜarḍ 24, ᶜarḍ 29* and *ᶜarḍ 32.*

In the lower half, there are shadow squares, on the left for a base of 12 and on the right for a base of 7. The vertical and horizontal scales on both sides are divided and numbered accordingly and carry the usual labels.

The space inside the shadow squares is not filled with astrological tables as in the other astrolabes and is left empty. The large empty spaces here, in the upper right quadrant and also in the lower rim lend a certain elegance to the back of this astrolabe.

The rim of the lower half is filled with the cotangent scales and their subdivisions in two rows. In the two following semi-circular rows are engraved the names of the 28 lunar mansions and those of the 12 zodiac signs.

ALIDADE

The alidade has ornate ends and an ornate centre-piece. The sighting vanes have three holes each. The very large upper hole was probably meant for a sighting tube which is no longer there. The surface of the alidade is engraved with three scales. On the right are a sexagesimal scale and a scale of unequal hours. On the left is a zodiac scale with the signs marked by their serial numbers.

The pin with round head may or may not be original. But the wedge, nicely shaped like a horse’s head with eyes, is original.

BIBLIOGRAPHY

Gunther 1932, I, no. 90, pp. 218-220, plates XLVIII-XLIX and Fig. 113, showing the front, back, and plates 6a, 7b and 8a.

A100⊙ SHIP ASTROLABE ATTRIBUTABLE TO ḌIYĀ’ AL-DĪN MUḤAMMAD

Not dated, 17th century

Diameter 241 mm

New Delhi, Archaeological Museum, Red Fort (#40.416)

Figure A100.1 – Front of the astrolabe (photo by S. R. Sarma)

This unsigned and undated astrolabe with two *zawraqī* horizons shares many features with the preceding six astrolabes and also with A104 so that it can undoubtedly be attributed to Ḍiyā’ al-Dīn.[482]

COMPONE NTS

Body (d. 241, h. 278, t 9) with shackle and ring, rete and 5 plates. The alidade, pin and horse are missing.

FRONT

The ring is simple. The shackle is trifoliate in shape; its two bases are shaped like flowers with five petals. The *kursī* with lobed profiles is plain and solid. The *kursī,* the limb and the back plate are made separately and joined together. As in A104, there are four rotatable lugs affixed to the limb to hold the plates and the rete in position. While these are necessary in A104, they are redundant here because here all the plates have notches at the north point into which the lug inside the limb fits. Moreover, the astrolabe was originally equipped with a pin and a wedge. The limb has a higher content of copper; it is divided in 0;30°, 1° and 3° and numbered in 3s from 3 to 90 clockwise, separately in each quadrant.

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482 Regrettably my photos do not do justice to this important astrolabe; it is also regrettable that my notes of 16, 17 and 19 February 1999 are partly mislaid.

Figure A100.2 – Rete with two horizons for 27° and 36° (photo by S. R. Sarma)

RETE

The rete contains a high proportion of copper or it is completely made of this metal. Here the peripheral ring of the Capricorn and the ecliptic ring are joined by the equinoctial and solstitial bars, both fully represented. There are counter changes in the equinoctial bar, but these are not clearly defined. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names. Each sign is subdivided in groups of 6° and numbered accordingly. The edge of the ecliptic ring is divided in 1°. There are about 44 named stars which are joined by a floral tracery consisting of tulips with flared petals. There is a small handle on the peripheral ring at the north-west point.

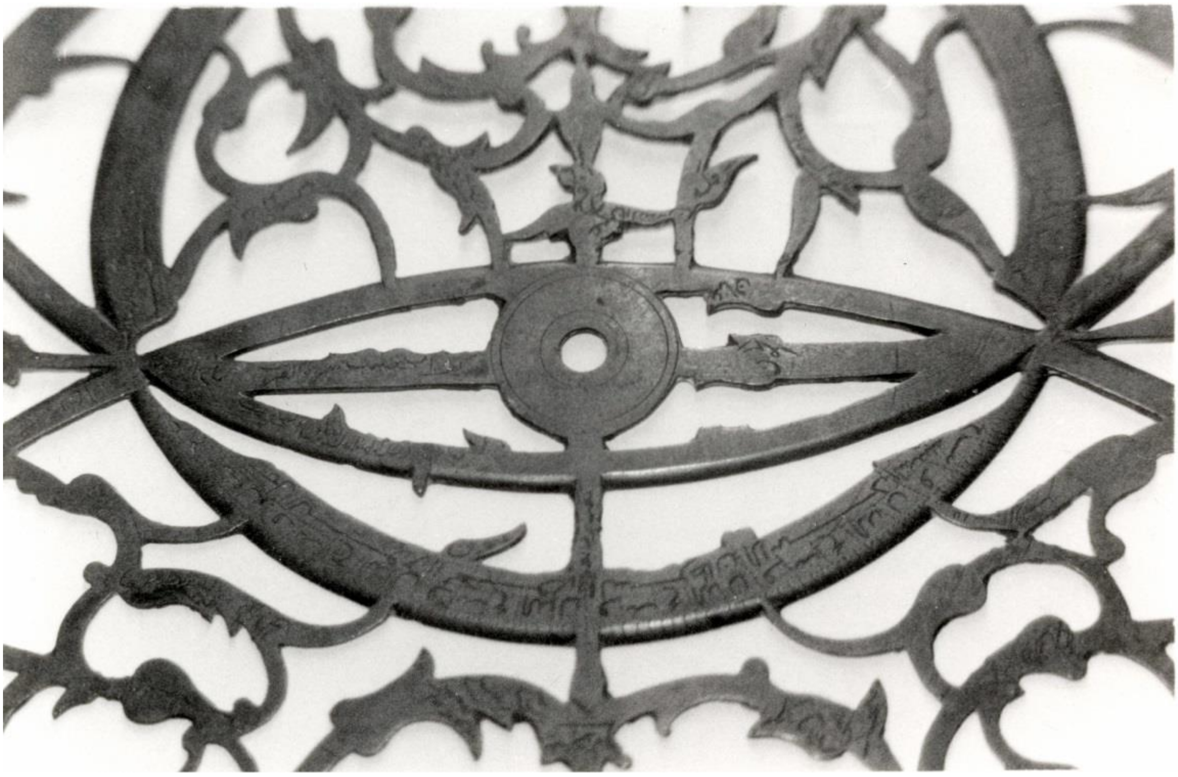

Figure A100.3 – Rete, detail (photo by S. R. Sarma)

Two *zawrāqī* horizons intersect at the two equinoctial points and extend up to the peripheral ring on both sides. The horizon with its convex side towards the south is for the latitude 27°. The eastern and western halves of the arc carry the labels *ufq mujassam sharqī bi- ᶜarḍ 27* (eastern solid horizon for latitude 27) and *ufq mujassam gharbī bi-ᶜarḍ 27* (western solid horizon for latitude 27) respectively. The second horizon with its convex side towards north is for the latitude 36°; its two halves carry the labels *ufq mujassam sharqī bi-ᶜarḍ 36* (eastern solid horizon for latitude 36) and *ufq mujassam gharbī bi-ᶜarḍ 36* (western solid horizon for latitude 36) respectively.

There is a long label on the segment of the equinoctial bar between the centre and its intersection with the ecliptic ring in the east, but I cannot decipher it.

As will be shown below, the plates serving the latitudes of 27° and 36° are specially prepared for use with these *zawraqī* horizons.

PLATES

There are five plates with varying thickness; three have a thickness of less than 1 mm, one plate is a little thicker than 1 mm and plate 1 is very thick with 1.5 mm. On plates 1 to 4 altitude circles are drawn for 1° and every sixth is highlighted with dots; azimuth arcs are drawn below the horizon for each 6° and every fifth is dotted. There

are plain lines for seasonal hours and dotted lines for equal drawn from the western horizon. The values of the maximum duration of daylight are inaccurate in all cases save for 32° which is the latitude of Lahore.

Table A100-1 Plates

	φ	Longest day
1a	24°	13 hours!
1b	26°	13 hours!
2a	27°	13 hours!
2b	29°	13;14 hours!
3a	32°	14;8 hours
3b	38°	14 hours!
4a	34°	14 hours!
4b	36°	14 hours!
5a	Tablet of ecliptic coordinates with the label *ṣafīḥat mīzān al-ᶜankabūt*	
5b	Tablet of horizons with the label *ṣafīḥa āfāqī*	

On plate 2a for 27° the ecliptic circle is drawn, divided into the 12 signs, labelled with their names and further subdivided in 6° and 1°. About 24 star positions are marked with dots enclosed in circles with their names engraved. On plate 4b for 36° also the ecliptic is engraved in the same manner and about 23 star positions are marked; some of these not identical with those marked on plate 2a.

Geographical Gazetteer

There is a gazetteer in five circles with the names and the coordinates of 121 localities; the arrangement is as in A095.

Figure A100.4 – Geographical Gazetteer (photo by S. R. Sarma)

BACK

The rim of the upper half carries altitude scales divided in 0;30°, 1° and 3° and numbered in 3s, from 3 to 90, as 3—90; 90—3. The upper left quadrant resembles the same in A095, A097 and A101 with 60 horizontal and 60 vertical parallels, half circles over the two radii, a radial drawn from the centre to 45° on the arc, and a line joining the two extremities of the arc.

In the solar quadrant on the upper right are drawn 18 declination circles, i.e., one for each 10° of the solar longitude; each third is highlighted with the dots. The names of the related signs, along with the subdivisions 10° are engraved on the two radii. Here are drawn four sigmoid curves of the midday altitude of the sun at latitudes 24°, 26°, 29° and 36°. The last one is accompanied by the full label *khaṭṭ niṣf al-nahār bi-ᶜarḍ 36.* The others are given shorter labels *bi-ᶜarḍ 24, bi-ᶜarḍ 26* and *bi-ᶜarḍ 29.*

In the lower half are shadow squares. These are enclosed by a series of semi-circular rows. The outermost row on the rim contains cotangent scales; the rows that follow carry respectively the names of the lunar mansions, the names of the zodiac signs, the limits of signs, the triplicities, the decans and their respective regents. Inside the shadow squares, there other astrological tables, but my notes on them are mislaid.

A101 SHIP ASTROLABE ATTRIBUTABLE TO ḌIYĀ' AL-DĪN MUḤAMMAD[483]

Not dated, 17th century

Diameter not known

PLU

Figure A101.1 – Front of the astrolabe (photo courtesy Museum of the History of Science, Oxford)

483 Entry based on photos of the front, back and gazetteer, and photocopies of all plates in the archives of the Museum of the History of Science, Oxford.

This unsigned and undated astrolabe can be attributed to Ḍiyā’ al-Dīn Muḥammad because of the *zawraqī* horizon on the rete and the 6 sigmoid curves of the midday altitude of the sun on the back. The back and the geographical gazetteer have a close resemblance to those in A095. As in A095 and A099, the maximum duration of the daylight at different latitudes is given imprecisely.

COMPONENTS

Body with *kursī,* shackle and chain, rete, 5 plates. No information about the alidade, pin and wedge.

FRONT

There is no ring, but a broken chain. The shackle is not trifoliate. Probably both the chain and the shackle are replacements. The *kursī* is indifferently reticulated with some ornamental engravings on the surface, but without the customary trifoliate finial.

The degree scale on the limb is divided in 0;30°, 1°, 2°, 3°, 6° and 30°. The lines separating 2° are dotted. At the top of the 3° mark is engraved a glyph like ‘v’. Three dots are engraved above and below the line separating every 30°. Groups of 6° are numbered clockwise in bold *abjad* symbols from 6 to 90, separately for each quadrant.

RETE

The peripheral Capricorn ring and the slightly wider ecliptic ring are held together by the equinoctial and solsticial bars, both represented completely; the former has two counter changes at its intersections with the ecliptic ring, the latter one counter change at the centre. The ecliptic ring is divided into the 12 signs and engraved with their names; each sign is divided in groups of 6° and numbered from 6 to 30; each of these 6° units subdivided to 2°. On the peripheral ring, there is a handle some 40° to the west of the north point.

A single oblique horizon for latitude 24° spans across the rete with its convex side to the south. The eastern half carries the labels *ufq mujassam sharqī bi-ᶜarḍ 24* (eastern solid horizon at latitude 24) and the western half *ufq mujassam gharbī bi-ᶜars 34* (obviously an error for *ᶜarḍ 24*) (western solid horizon at latitude 24).

There are 46 named star pointers, but many of these are not defined well.

Table A101-1 Stars on the Rete

	Star Names	Identification
1	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
2	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
3	*Baṭn Ḥūt*	β Andromedae
4	*Rijl Musalala*	γ Andromedae
5	*Fam al-Qayṭus*	γ Ceti
6	*Ṣadr al-Qayṭus*	π Ceti
7	*Rās al-Ghūl*	β Persei
8	*Kaff al-Jadhmā’*	α Ceti
9	*Tālī Masāfat al-Nahr*	γ Eridani
10	*ᶜAyn al-Thawr*	α Tauri
11	*ᶜAyyūq*	α Aurigae
12	*Rijl al-Jawzā’ al-Yusrā*	β Orionis
13	*Yad al-Jawzā’ al-Yusrā*	γ Orionis
14	*Yad al-Jawzā’ al-Yumnā*	α Orionis
15	*Rijl al-Jawzā al-Yumnā*	κ Orionis
16	*??*	
17	*Shiᶜrā Yamānī*	α Canis Majoris
18	*Shiᶜrā Shāmī*	α Canis Minoris
19	*Minkhir al-Shujāᶜ*	σ Hydrae
20	*Ṭarfat al-Safīna*	ρ Puppis
21	*Fard al-Shujāᶜ*	α Hydrae
22	*Qā’idat al-Bāṭiya*	α Crateris
23	*Ṣarfa*	β Leonis

	Star Names	Identification
24	*Minqār al-Ghurāb*	α Corvi
25	*ᶜAnāq*	ζ Ursae Minoris
26	*Simāk Aᶜzal*	α Virginis
27	*Simāk Rāmiḥ*	α Bootis
28	*Siffah* (read: *Kiffa J*?)	α Librae ?
29	*Nayyir Fakka*	α Coronae Borealis
30	*Qalb al-ᶜAqrab*	α Scorpii
31	*Rukbat al-Ḥawwā’ al-Yusrā*	ζ Ophiuchi
32	*Rās al-Jāthī*	α Herculis
33	*Rās al-Ḥawwā’*	α Ophiuchi
34	*Yad al-Ḥawwā’ al-Muqaddam*	δ Ophiuchi
35	*Tinnīn*	γ Draconis
36	*Nasr Wāqiᶜ*	α Lyrae
37	*Minqār al-Dajāja*	β Cygni
38	*Nasr Ṭā’ir*	α Aquilae
39	*Dhanab al-Dālfīn*	ε Delphini
40	*Dhanab al-Dajāja*	α Cygni
41	*Fam al-Faras*	ε Pegasi
42	*Dhanab al-Jadī*	δ Capricorni
43	*Sāq Sākib al-Mā’ J[anūbī]*	δ Aquarii
44	*Surrat Faras*	δ Pegasi
45	*Janāḥ Faras*	γ Pegasi
46	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are photocopies of 10 plate faces, but it is not known which two faces belong together. Therefore they are numbered below from 1 to 10.

Table A101-2 Plates

	φ	Longest Day
1	18°	13 hours
2	21°	13 hours
3	24°	13 hours
4	27°	13 hours
5	29°	13;52 hours
6	32°	14;8 hours
7	34°	14 hours
8	36°	14 hours
9	Tablet of ecliptic coordinates	
10	Tablet of horizons	

It is remarkable that, as in astrolabes A095 and A099, the maximum duration of daylight at different latitudes is given imprecisely, either as 13 hours or as 14 hours. The exceptions are the latitudes 29° (Delhi) and 32° (Lahore). It does not need much effort to give the more exact values in hours and minutes. It is intriguing why it is not done so in otherwise well-crafted plates.

On plate faces 1-8, altitude circles are drawn for every 2°. Azimuth arcs are traced for every 6° below the horizon and those for every 30° are both up and below the horizon as dotted lines. There are lines for seasonal hours as well as dotted lines for equal hours drawn from the western horizon.

The tablet of horizons has rather an unusual design. Here half horizons are drawn in four sets for every degree of latitude from 4° to 90° at intervals of 4°:

4	8	12	…	72	76	80	84	88	90
5	9	13	…	73	77	81	85	89	90

6	10	14	…	74	78	82	86	90
7	11	15	…	75	79	83	87	90

Declination scales are drawn between the two tropics at NW, NE, SW and SE points. The divisions in the scales are not clearly marked. They are numbered as 6, 12, 18, 24 from the equator to the Tropic of Capricorn and from the equator to the Tropic of Cancer.

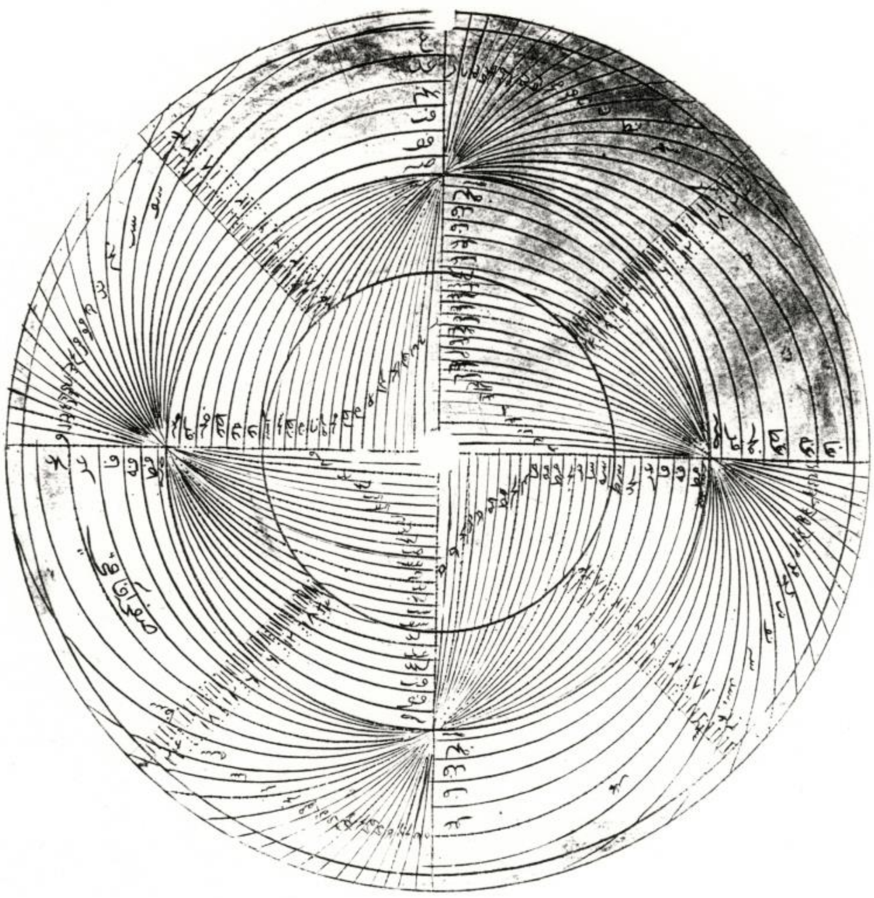

Figure A101.2 – Tablet of horizons
(photocopy courtesyMuseum of the History of Science, Oxford)

Plate 4 also deserves a special mention. In the preceding astrolabe (A099), the plate for latitude 29° is stamped with several punch marks as star pointers. Here also the plate for latitude 24° is endowed in the same manner with punch marks with star names below. Probably because of the quality of the photo, these marks are not clearly visible, particularly to the south of the horizon. Listed below are the names of 31 stars which can be discerned.

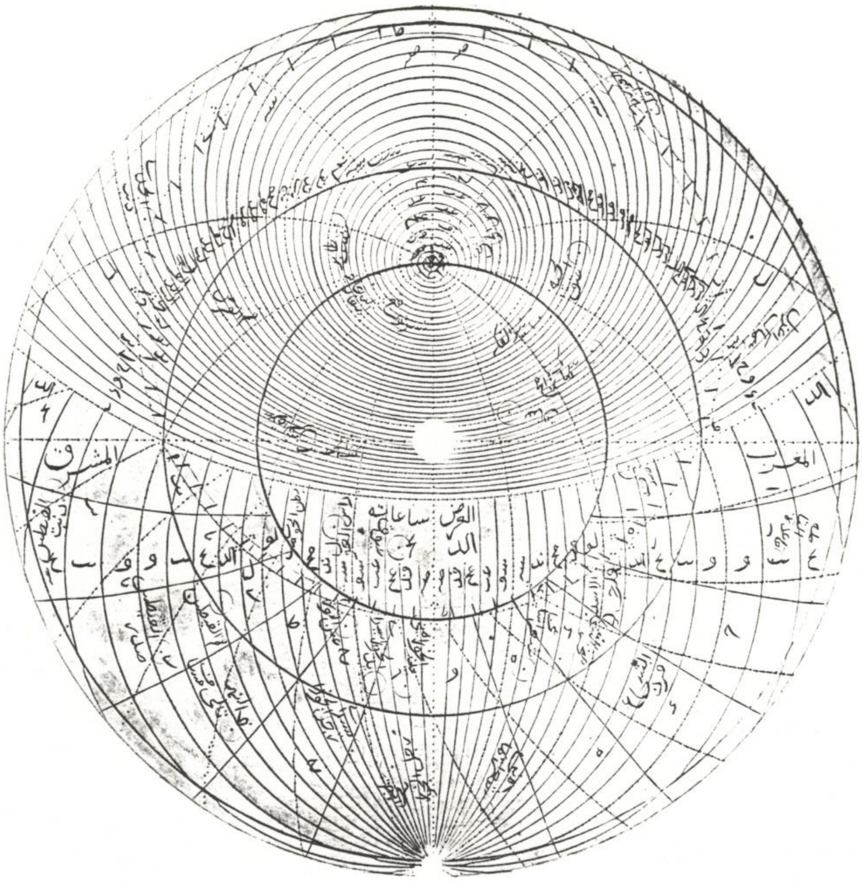

Figure A101.3 – Plate 4 for latitude 24 with star positions
(photocopy courtesy Museum of the History of Science, Oxford)

Table A101-3 Stars on Plate 4

	Star Name	Identification
1	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
2	*Fam al-Qayṭus*	γ Ceti
3	*Ṣadr al-Qayṭus*	π Ceti
4	*Rās al-Ghūl*	β Persei
5	*Tālī Masāfat al-Nahr*	γ Eridani
6	*ᶜAyn al-Thawr*	α Tauri
7	*ᶜAyyūq*	α Aurigae
8	*Rijl al-Jawzā’ Yusrā*	β Orionis

	Star Name	Identification
9	*Yad al-Jawzā’ Yusra*	γ Orionis
10	*Yad al-Jawzā’ Yumnā*	α Orionis
11	*Rijl al-Jawzā’ Yumnā*	κ Orionis
12	*Shiᶜrā Yamānī*	α Canis Majoris
13	*Shiᶜrā Shāmī*	α Canis Minoris
14	*Minkhir al-Shujāᶜ*	σ Hydrae
15	*Fard al-Shujāᶜ*	α Hydrae
16	*Qalb al-Asad*	α Leonis
17	*Qā’idat al-Bāṭiya*	α Crateris
18	*Ṣarfa*	β Leonis
19	*Simāk Aᶜzal*	α Virginis
20	*ᶜAnāq*	ζ Ursae Majoris
21	*Simāk Rāmiḥ*	α Bootis
22	*ᶜUnq al-Ḥayya*	α Serpentis
23	*Nayyir al-Fakka*	α Coronae Borealis
24	*Qalb al-ᶜAqrab*	α Scorpii
25	*Nasr Wāqiᶜ*	α Lyrae
26	*Nasr Ṭā’ir*	α Aquilae
27	*Dhanab al-Dulfīn*	ε Delphini
28	*Fam al-Faras*	ε Pegasi
29	*Dhanab al-Jadī*	α Capricorni
30	*Surrat al-Faras*	δ Pegasi
31	*Kaff al-Khaḍīb*	β Cassiopeiae

GEOGRAPHICAL GAZETTEER

On the inner surface of the mater is engraved in four circles a geographical gazetteer of 108 localities, arranged according to climates. But the fourth circle is placed very close to the central hole and the entries there are cluttered and undecipherable. The sequence of the entries is not consistent in all circles. While the place name is followed by the longitude and latitude in the first, third and fourth circles, in the second circle the place name is followed by latitude and longitude. Moreover, the number 20 is represented by two different glyphs: the common symbol used in *abjad* notation as well as ک . It appears that, like the gazetteer in A095, this one too may have been engraved by an assistant and not by Ḍiyā'al-Dīn himself.

Figure A101.4 – The geographical gazetteer, shown here upside down so that the beginning can be read easily (photo courtesy Museum of the History of Science, Oxford)

Table A101-4 Geographical Gazetteer

	Place Names	L	φ	
	First Circle			
[-I] *az khaṭṭ istiwā* (from the line of equator)				
1	Sāḥil bahr Awkiyānūs	6;0	0;0	
2	Jazīra Qanbala	21;0	3;0	
3	Jamkūt	180;0	5;0	
4	Shala	170;0	5;0	
[I] *iqlīm awwal* (first climate)				
5	Kūkū	54;10	10;0	
6	ᶜAdan	76;0	11;0	
7	Jubla	75;0	33;0	(read: 13;0)
8	Damār	77;10	33;30	(read: 13;30)
9	Bahr ---	110;0	14;0	
10	Dabīl	74;0	14;0	
11	Ṣanᶜā’ Dar al-Mulk Yaman	77;30	14;0	
12	Janad	75;30	14;30	
13	Sawmnāt	107;0	17;0	
14	Zaytūn	154;0	17;0	
15	Bījāpūr	105;30	17;20	
16	Burhānpūr	113;0	20;30	
17	Dawalatābād	111;0	20;30	
[II] *iqlīm dūyum* (second climate)				
18	Jadda	76;0	21;0	
19	Ṭāᶜif	77;30	21;20	

	Place Names	L	φ
20	Makka Muᶜaẓẓam	77;10	21;40
21	Kanbayāt	109;20	24;20
22	Khaybar	75;20	25;20
23	Madīnat Musharrafa	75;20	25;0
24	Hurmūz	92;0	25;0
25	Ajmīr	111.5	26;0
26	Lakhnawtī	114;30	26;30
27	Qannawj	105;50	26;15
28	Jawnbūr	119;4	26;36
29	Akbarābād	114;0	26;43
30	Kūpāmāū	116;33	26;45
31	Kara Mānikpūr	118;6	26;46
32	Awadh	118;10	27;22
33	Badāwan	119;36	27;32
34	Kwāliyār	116;0	26;29
[III] *iqlīm siwum* (third climate)			
35	Kūlkanada	114;19	18;6
36	Kūl Jalālī	114;19	28;6
37	Fīrūzābād	106;30	28;7
38	Sulṭānkūt	115;0	28;30
39	Shāhjahānābād	113;35	29;0
40	Baran	114;0	28;43
41	Pānīpat	113;20	28;20

	Place Names	L	φ	
42	Shīrāz	108;0	29;36	
43	Multān	107;35	29;40	
44	Hānsī	112;25	29;45	
45	Baṣra	87;0	30;0	
46	Kirmān	91;30	30;5	
47	Tahtaniṣr	112;33	30;10	(Tanesar)
	Second Circle			
tatimma iqlīm siwum (continuation of the third climate)				
48	Iskandariyya	61;15	30;33	
49	Miṣr	63;20	30;20	
50	Sunām	110;25	30;30	
51	Kūfa	106;0!	32;0	
52	Bayt al-Maqdis	66;30	31;50	
53	Lāhūr	109;20	31;50	
54	Yazd	89;0	32;0	
55	Iṣfahān	87;40	32;25	
56	Qandahār	107;40	33;0	
57	Sālkūt	109;0	33;0	
58	Madā’īn	72;0	33;0	
59	Dimashq	70;0	33;0	
60	Mīqand ?	80;0	33;25	
61	Baghdād	82;0	33;25	
[IV] *iqlīm chahārum* (fourth climate)				
62	Ṭarabīs (read: Ṭarābulus)	69;40	34;0	

	Place Names	L	φ
63	ᶜAnah	76;0	34;0
64	Kāshān	86;0	34;0
65	Mawṣil	77;0	34;30
66	Tūn	92;30	34;30
67	Harāt	104;30	34;30
68	Kābul	104;40	34;30
69	Qumm	105;40	34;45
70	Rayy	86;20	35;20
71	Sāwa	85;0	30;0
72	Kashmīr	108;0	35;0
73	Hamadān	83;0	35;10
74	Mashhad Maqdis	92;30	36;0
75	Ḥalab	72;10	35;50
76	Sabzawār	91;30	34;5
77	Balkh	101;0	36;41
78	Tāliqān	101;45	36;10
	Third Circle		
tatimma iqlīm chahārum (continuation of the fourth climate)			
79	Qazwīn	85;0	35;15
80	Badakhshān	84;24	37;10
81	Sarakhs	94;30	36;30
82	Marw	97;0	37;40
83	Tabrīz	82;0	38;0
84	Ardabīl	80;0	38;0

	Place Names	L	φ
85	Nakhjawān	81;15	38;40
86	Biṣṭām	89;30	36;14
[V] *iqlīm panjum* (fifth climate)			
87	Samarqand	99;36	39;37
88	Bukhārā	97;30	39;50
89	Tubbat	110;0	40;0
90	Bardhaᶜa	83;0	40;0
91	Khujand	85;30	41;55
92	Khutan	87;0	42;0
[VI] *iqlīm shashum* (sixth climate)			
93	Kāshghar	106;30	44;0
94	Tarāz	101;0	44;50
95	Pīsh Bāligh	111;0	44;0
96	Shalj	85;30	44;0
[VII] *iqlīm haftum* (seventh climate)			
97	Araq	105;0	48;0
98	Bulghār	90;0	49;0
99	Qirqir	65;0	50;0
khāriz iqlīm -- ? (Beyond the --- climate)[484]			
100	Ṣūrath (read: Sūrat)	110;50	20;15
101	Banāras	117;20	26;0

[484] The third word is not clear. What follow are not localities beyond the seventh climate, but places in India.

	Place Names	L	φ
	Fourth Circle		
102	Dhākā Bankālā[485]	---	---
103	Ilāhābād	---	---
104	Sarhind	---	---
105	Patnah	---	---
106	Bahrūj	---	---
107	Munkīr	---	---

BACK

The rim of the upper half carries the altitude scales which are divided, as on the limb, in 0;30°, 1°, 2°, 3°, 6° and 30°. Groups of 6° are numbered in *abjad* symbols which are bolder than on the limb, as 6—90; 90—6. The four quadrants are designed exactly as on the back of A091.

In the upper left quadrant is a sexagesimal sine-cosine graph with very finely drawn 60 horizontal parallels and 60 vertical parallels, where each sixth line is highlighted with dots. There are also engraved semi-circles on both the radii; 3 quarter circles around the centre at 24 units (the arc of the obliquity of the ecliptic), 12 units (?) and 8 units (?). A radial line is drawn from the centre to 45° on the arc and another line between two inner terminals of the arc.

In the upper right quadrant, declination arcs are drawn for each 10° of solar longitude; every third of these is dotted. The names of the corresponding signs and the numerical values of the subdivisions are engraved along the two radii. There are dotted arcs of unequal hours, numbered from 1 to 6 in an anticlockwise direction and 7 to 12 in the reverse direction. There are also drawn 6 sigmoid curves to show the midday

485 The coordinates of this and the next places are difficult to decipher.

altitude of the sun throughout the year at 6 different latitudes, viz. 21° (Mecca), 24° (Tropic of Cancer), 27° (Agra), 29° (Delhi), 32° (Lahore), 36°(middle of the fourth climate, i.e., the middle of the inhabited world). Only the lowermost curve is accompanied by a full label which reads *khaṭṭ niṣf al-nahār bi-ᶜarḍ 36°*. For other curves just the latitude is mentioned as *ᶜarḍ 21, ᶜarḍ 24* and so on.

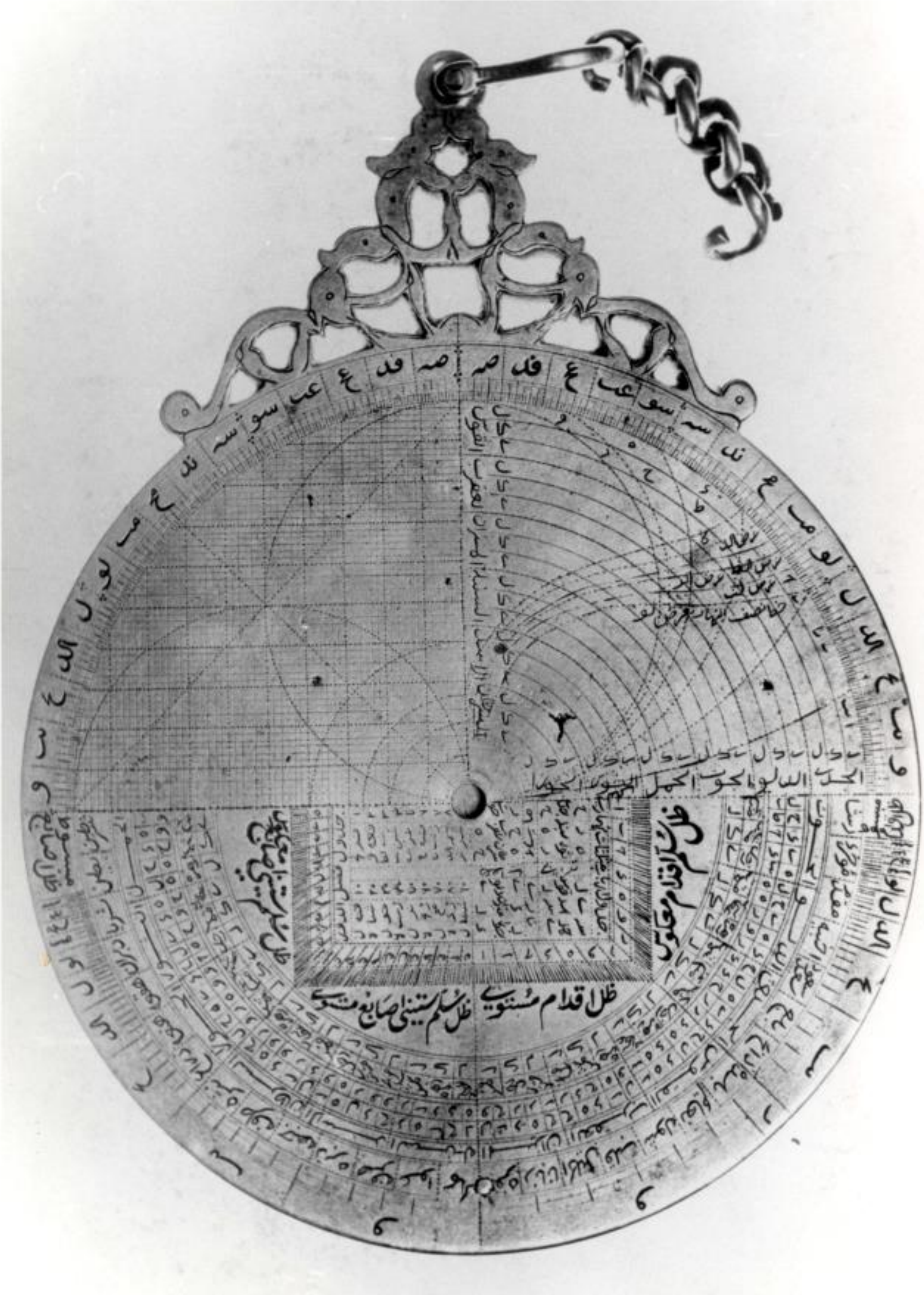

Figure A101.5 – Back of the astrolabe (photo courtesy Museum of the History of Science, Oxford)

In the lower half are drawn the shadow squares. On the left is the square for gnomons of 12 digits as well as of 60 divisions. The vertical and horizontal scales on the left are divided into 12 units and numbered from 1 to 12. Each unit is further subdivided into 5 divisions. The vertical scale carries the label *ẓill sattaynī aṣābi*^{c} *ma*^{c}*kūs*

(reverse shadows of sexagesimal divisions and [twelve] digits) and the horizontal scale the label *ẓill sattaynī aṣābiᶜ* (direct shadows of sexagesimal divisions and [twelve] digits).

On the right is the square for gnomons of 7 feet and of 7 x 7 divisions. The vertical and horizontal scales on the right are each divided into 7 units each and are numbered from 1 to 7. As in A097, each unit is further subdivided in 7 divisions which is unusual. The vertical scale has the label *ẓill aqdām maᶜkūs* (reverse shadows in feet) and the horizontal scale *ẓill aqdām mustawī* (direct shadows in feet). These four labels of the shadow squares are bold like the *abjad* numbers on the rim.

Inside the shadow squares, there are two rectangular tables. The one on the right is a table of triplicities with the title *jadwal arbāb muthallathāt nahārī wa laylī* (table of the regents of the triplicities diurnal and nocturnal). Next to it is the table designated as *faḍl al-dawr* (excess of revolution).

The rim of the lower half is engraved with cotangent scales in the outer semi-circular row and their subdivisions in the inner row.

The next two rows are engraved with the names of the 12 signs of the zodiac and the names of the 28 corresponding lunar mansions respectively. These are followed by two rows containing the table of the limits of the signs (*ḥudūd*), while the last two rows carry the table of faces (*wujūh*).

A102⊙ SHIP ASTROLABE ATTRIBUTABLE TO ḌIYĀ’ AL-DĪN MUḤAMMAD[486]

Not dated, 17th century

Diameter 100 mm

Chicago, Adler Planetarium (#M39)

CCA 91

Figure A102.1 – Front of the astrolabe
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

486 Entry based on Pingree 2009, no. 20, pp. 88-93; the star list has been rearranged according to increasing right ascension.

This unsigned and undated astrolabe can be attributed to Ḍiyā’ al-Dīn Muḥammad because of the *zawraqī* horizons. Its construction is unusual. The mater has upraised limbs on both sides so that there are recesses where plates and retes can be inserted. There are two retes, one standard one and the other consisting just of two *zawraqī* horizons and the corresponding masts; these can be simultaneously used by inserting them into the mater on either side. Similar construction is adopted in another astrolabe to be discussed below (A104) where the mater is equipped with recesses on both sides to accommodate a northern rete and a southern rete.

COMPONENTS

Body with *kursī* (d. 100, h. 142) with ring and shackle, two retes (one standard for 33 stars; the other *zawraqī*), 4 plates, alidade, pin and horse.

FRONT

A large ring and trifoliate shackle. The profiles of the *kursī* are made up of ogees at the base followed by three lobes. Engraved with a pattern of tiny pearls, the rim forms an appropriate frame around the calligraphy *Yā Fattāh.* It is a sacred phrase in Islam addressing God as ‘O Fattāh, the Opener’.

On both sides, the degree scale on the limb is divided in 1° and 5° and numbered clockwise from 5 to 90, separately in each quadrant.

RETE I

In the larger rete, the peripheral Capricorn ring and the ecliptic ring are held together by the equinoctial bar which has counter changes at its two intersections with the ecliptic ring. The ecliptic ring is divided into the 12 signs of the zodiac and engraved with their names. Each sign is divided in groups of 6° and numbered from 6 to 30. The edge of the ecliptic ring is divided in 2°. There are 33 named star pointers, shaped like tiger’s claws, and these are joined by small unconnected traceries.

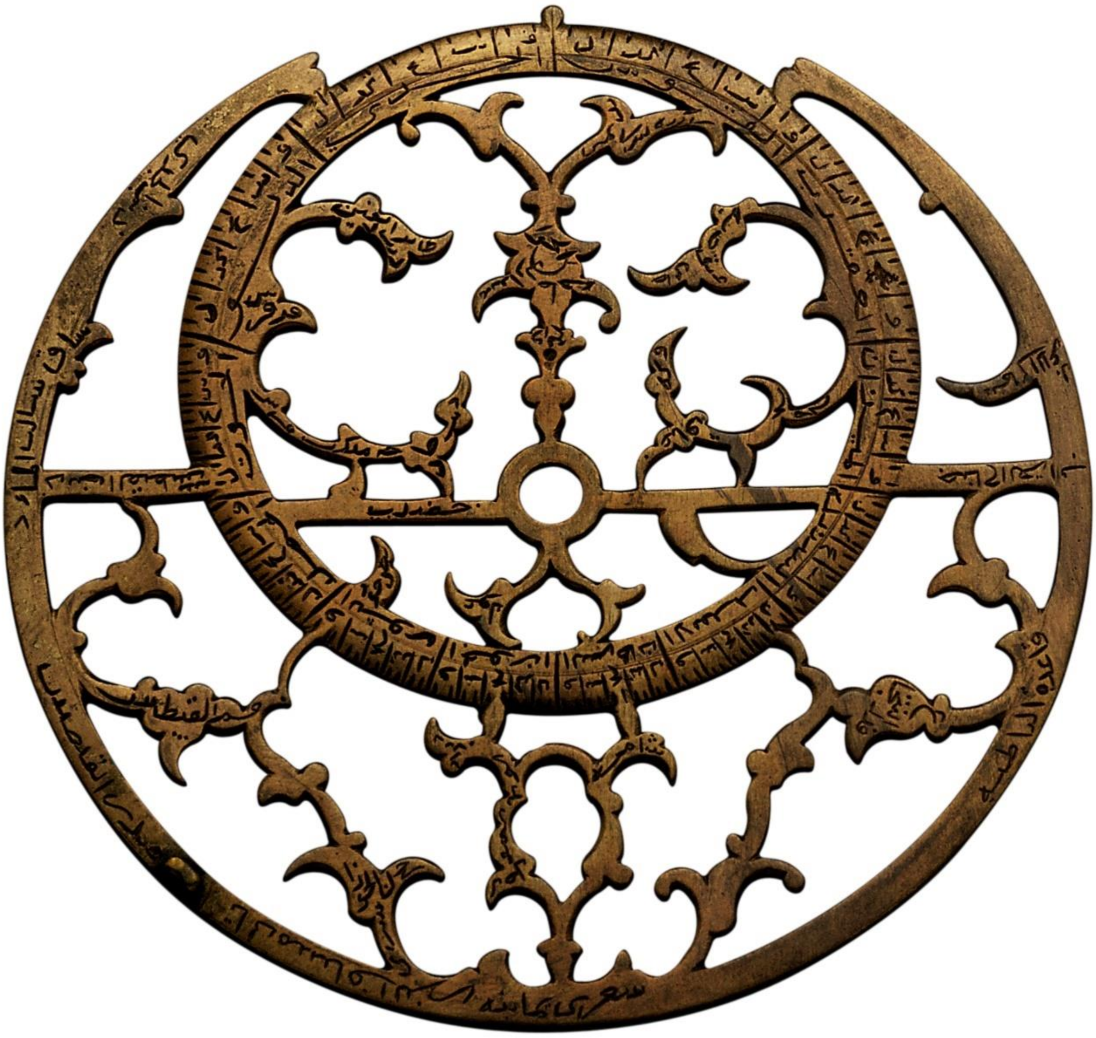

Figure A102.2 – The standard rete in the astrolabe
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

Table A102-1 Stars on the Rete

	Star Name	Identification
1	*Baṭn Ḥūt*	γ Andromedae
2	*Fam al-Qayṭus*	γ Ceti
3	*Ṣadr al-Qayṭus*	π Ceti
4	*Ghūl*	β Persei
5	*Tālī Masāfat al-Nahr*	γ Eridani
6	*Dabarā[n]*	α Tauri
7	*Rijl al-Jawzā’ Yusrā*	β Orionis

	Star Name	Identification
8	*Yad Yamīn*	α Orionis
9	*Rijl Yumnā*	κ Orionis
10	*Shiᶜrā Yamānī*	α Canis Minoris
11	*Shāmī*	α Canis Majoris
12	*Fard al-Shujāᶜ*	α Hydrae
13	*Qā’idat al-Bāṭiya*	α Crateris
14	*ᶜAnāq*	ζ Ursae Majoris
15	*Janāḥ al-Ghurāb*	γ Corvi
16	*Simāk al-Aᶜzal*	α Virginis
17	*Fakka*	α Coronae Borealis
18	*ᶜUnq Ḥayya*	α Serpentis
19	*Rukba Yusrā*	ζ Ophiuchi
20	*Jāthī*	α Herculis
21	*Al-Ḥawwā’*	α Ophiuchi
22	*Yad Yamīn*	δ Ophiuchi (?)
23	*Wāqiᶜ*	α Lyrae
24	*Minqār Dajāja*	β Cygni
25	*Ṭā’ir*	α Aquilae
26	*Dhanab al-Dulfīn*	ε Delphini
27	*Dhanab Dajāja*	α Cygni
28	*Fam Faras*	ε Pegasi
29	*Dhanab al-Jadī*	δ Capricorni
30	*Sāq Sākib al-Mā’*	δ Aquarii
31	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti

	Star Name	Identification
32	*Mankib Faras*	β Pegasi
33	*Khaḍīb*	β Cassiopeiae

Figure A102.3 – The *zawraqī* rete
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

RETE II

The second rete consists of a peripheral ring in which two mutually intersecting arcs are placed above and below the centre; the arcs extend up to the peripheral ring on both sides. Two segments of the solstitial bar above and below the centre are the masts.

The arc with its convex side to the north is the oblique horizon of latitude 38°. The two halves of this arc carry the labels *ufq mujassam sharqī bi-*^{c}*arḍ 38* (eastern solid horizon for latitude 38) and *ufq mujassam gharbī bi-*^{c}*arḍ 38* (western solid horizon for latitude 38) respectively. The mast corresponding to this arc, i.e., the solstitial bar above the central hole, has the inscription ^{c}*ayr dawraq* (?).

The second arc, with the convex side to the south is the oblique horizon for latitude 37°. The two halves of this arc carry the labels *ufq mujassam sharqī bi-ᶜarḍ 37* (eastern solid horizon for latitude 37) and *ufq mujassam gharbī bi- ᶜarḍ 37* (western solid horizon for latitude 37). Its mast, i.e., the solstitial bar below the central hole, bears the label *tayr dawraq* (?). The significance of these two latitudes is not known.

There are notches in the peripheral ring at the south and north points so that the rete can be fitted appropriately when using either of the two oblique horizons. There are also such notches at the east and west points, but on the inner side of the ring. Their precise function is not understood. Moreover, there is no plate designed to use with these *zawraqī* horizons as in A013 or A082, or a plate with star positions marked as in A099 and A100.

Plates

The astrolabe has four plates with the following specifications.

Table A102-2 Plates

	φ	Longest Day
1a	22°	13;22 hours
1b	25°	13;25 (read 13;35) hours
2a	27°	13;43 hours
2b	32°	14;8 hours
3a	30°	13;58 hours
3b	36°	14;42 hours
4a	0°+72°	
4b	Substitute for normal back	

The first three plates are engraved with altitude circles for every 2° and with lines for seasonal and equal hours, but not with azimuth arcs. They are crudely produced and are given a silver finish. They are probably replacements for the original plates which are lost.

Plate 4a carries a double projection. The upper half is designed for latitude 0°. Under the straight horizon in the east and west is engraved *lā ᶜarḍ lahū* (there is no latitude). The lower half is designed for latitude 72°; there are labels on both sides stating *al- ᶜarḍ 72.*

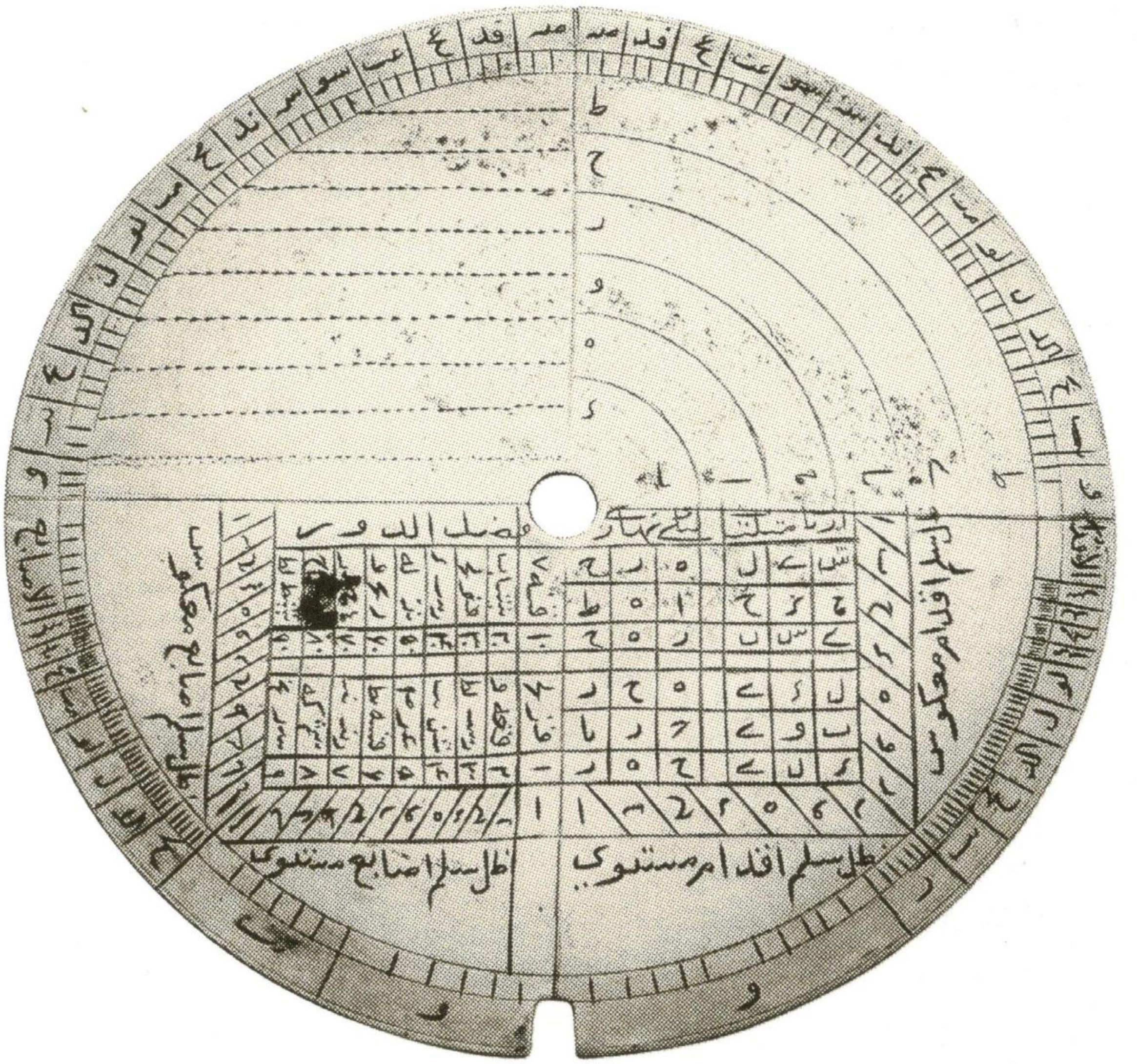

Figure A102.4 – Plate 4b designed as the Back of the Astrolabe
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

Plate 4b is designed as the normal back of the astrolabe. The rim of the upper half carries altitude scales while that on the lower half bears cotangent scales. In upper left is the trigonometric quadrant with 9 horizontal parallels. In the upper right quadrant, declination arcs are drawn for each 30° solar longitude, i.e., for each sign. The signs are marked with their serial numbers on both the radii. In the lower half, there are the shadow squares for 12 digits and 7 feet with the usual labels.

Figure A102.5 – The first part of the geographical Gazetteer on the reverse side of the mater
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

Geographical Gazetteer

A geographical gazetteer is engraved on the two sides of the recessed mater. The gazetteer is organised according to the climates and provides the names, longitudes and latitudes of 108 localities. The gazetteer begins on the reverse side of the mater and continues on the obverse side.

Table A102-3 Geographical Gazetteer I

	Place Name	L	φ	Identification/Modern Name
	Part I			

	Place Name	L	φ	Identification/Modern Name
	Outer Circle			
[-I] *az khaṭṭ istiwā tā iqlīm awwal* (from the line of equator up to the first climate)				
1	Jamkūt	180;0	5;0	Yamakoṭi
2	ᶜAdan	76;0	11;0	Aden, Yemen
3	Sarāndīb	130;0	10;0	Sri Lanka
4	Zabīd[487]	74;20	14;10	Zabid, Yemen
5	Jabal	75;0	13;30	Zuqar Island, Yemen
[I] *al-iqlīm awwal* (the first climate)				
6	Janad	75;30	14;30	Janad, Yemen
7	Sawmnāt	106;0	17;0	Somnath, Gujarat, India
8	Zaytūn	154;0	17;55	Hangzhou, China
9	Bījābūr	105;30	17;20	Bijapur, Karnataka, India
10	Ṭāᶜif	77;30	21;20	Taif, Saudi Arabia
11	Makka Musharraf	77;10	21;40	Mecca, Saudi Arabia
12	Madīnat Ṭayyība	75;10	25;0	Medina, Saudi Arabia
[II] *al-iqlīm dū[yu]m* (the second climate)				
13	Khaybar	75;20	74;30[488]	Khaybar, Saudi Arabia
14	Hurmūz	94;0	25;0	Hormoz, Iran
15	Akbarābād	115;0	26;43	Agra, UP, India
16	Kawāliyar	114;0	26;29	Gwalior, MP, India

487 This and the next locality should be in the first climate.

488 This value is clearly absurd.

	Place Name	L	φ	Identification/Modern Name
17	Qannawj	115;50	26;35	Kannauj, UP, India
18	Ajmīr	111;5	26;0	Ajmer, Rajasthan, India
19	Jadda	76;0	21;0	Jeddah, Saudi Arabia
20	Aḥmadābād	103;40	23;15	Ahmedabad, Gujarat, India
21	Burhānbūr	103;0	20;30	Burhanpur, MP, India
[III] *al-iqlīm siwum* (the third climate)				
22	Dawlatābād	111;0	20;30	Daulatabad, Maharashtra, India
23	Kanbāyat	109;20	22;20	Cambay, Gujarat, India
24	Qayrawān	41;0	31;40	Kairouan, Tunisia
25	Bayt al-Maqdis	66;30	31;50	Jerusalem, Israel
26	Kūfa	79;30	31;30	Kufa (ancient city in Iraq)
27	Miṣr	63;20	30;20	Cairo, Egypt
28	Madā’in	72;0	33;15	Al-Madā’in, Iraq
29	Dimashq	70;0	33;15	Damascus, Syria
30	Baghdād	82;0	33;25	Baghdad, Iraq
31	Fīrūzābād	87;30	28;10	Firouzabad, Iran
32	Yazd	89;0	32;0	Yazd, Iran
33	Iṣfahān	87;40	32;25	Isfahan, Iran
34	Shīrāz	83;0	29;36	Shīrāz, Iran
35	Kirmān	91;30	30;5	Kerman, Iran
	Inner Circle			
tatimma iqlīm siwum (continuation of the third climate)				
36	Qandahār	107;46	33;0	Qandahar, Afghanistan
37	Multān	107;35	29;42	Multan, Pakistan

	Place Name	L	φ	Identification/Modern Name
38	Burushwar	105;15	35;24	Peshawar, Pakistan
39	Siyālkūt	109;0	33;0	Sialkot, Pakistan
40	Lahāwar	109;20	31;50	Lahore, Pakistan
41	Tanīsar	112;33	30;10	Tanesar, Haryana, India
42	Dihlī	118;35	28;19	Delhi, India
43	Kūlkunda[489]	114;19	18;20	Golconda=Hyderabad, India
44	ᶜĀna	76;0	34;0	Ana, Iraq
45	Mawṣil	77;0	34;30	Mosul, Iraq
46	Karaj	85;45	34;0	Karaj, Iran
[IV] *al-iqlīm chahārum* (the fourth climate)				
47	Kāshān	86;0	34;0	Kashan, Iran
48	Qumm	85;40	35;45	Qom, Iran
49	Rayy	86;20	35;45	Shahr Rey, Iran
50	Sāwa	85;0	34;40	Saveh, Iran
51	Jurfādaqān	85;30	34;45	Golpayegan, Iran
52	Hamadān	83;0	35;0	Hamadan, Iran
53	Raqqa	73;15	36;0	Raqqa, Syria
54	Mashhad	92;30	36;0	Mashhad, Iran

489 It should be in the first climate.

Figure A102.6 – Continuation of the geographical gazetteer on the obverse side of the mater
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

Table A102-4 Geographical Gazetteer II

	Place Name	L	φ	Identification/Modern name
	Part II			
	Outer Circle			
Tatimma iqlīm chahārum (continuation of the fourth climate)				
55	Suhraward	83;20	36;0	Suhraward, Iran
56	Sabzawār	91;30	36;5	Sabzevar, Iran
57	Bisṭām	89;30	36;10	Bistam, Iran
58	Nīshābūr	92;30	36;21	Neyshabur, Iran
59	Abhar	84;30	36;45	Abhar, Iran

	Place Name	L	φ	Identification/Modern name
59	Astarābād	89;35	36;50	Gorgan, Iran
60	Qazwīn	85;0	36;15	Qazvin, Iran
61	Marāgha	82;0	37;20	Maragheh, Iran
62	Tabrīz	82;0	38;0	Tabriz, Iran
63	Nakhjawān	81;15	38;40	Nakhichevan, Azerbaijan
64	Balkh	101;0	36;51	Balkh, Afghanistan
65	Badakhshān	104;24	37;10	Badakhshan, Afghanistan
66	Marw	97;0	37;40	Mary, Turkmenistan
67	Harāt	94;30	34;30	Herat, Afghanistan
68	Kābul	104;40	34;30	Kabul, Afghanistan
69	Kashmīr	108;0	35;0	Kashmir=Srinagar, India
70	Ardabīl	80;30	38;0	Ardabil, Iran
71	Nawshahr	78;20	38;10	Nowshahr, Iran
72	Arjīsh	77;0	38;30	Ercis, Turkey
73	Sarakhs	94;30	37;30	Sarakhs, Iran
74	Bulūr	108;0	36;0	Khatlon region, Tajikistan
75	Andarāb	108;45	36;0	Andarab, Iran
76	Ṭāliqān	85;45	36;10	Taloqan, Afghanistan
77	Fāryāb	99;0	36;44	Doulatabad, Iran
78	Jurjān	90;0	36;50	Jurjān, Iran
79	Bākawiyya	84;30	39;30	Baku, Azerbaijan
[V] *al-iqlīm panjum* (the fifth climate)				
80	Samarqand	94;17	39;37	Samarqand, Uzbekistan
81	Bukhārā	97;30	39;50	Bukhara, Uzbekistan

	Place Name	L	φ	Identification/Modern name
82	Bardaᶜa	83;0	40;30	Barda, Azerbaijan
83	Shamākhī	84;30	40;50	Shemakhi, Azerbeijan
84	Qūnya	66;30	41;0	Konya, Turky
85	Khujand	105;35	41;55	Sughd, Tajikistan
86	Ṭāj	104;0	42;0	Tashkent, Uzbekistan
87	Khutan	107;0	42;0	Khotan, China
88	Farghāna	102;0	42;0	Fergana, Uzbekistan
	Inner Circle			
tatimma iqlīm panjum (continuation of the fifth climate)				
89	Bāb al-Abwāb	85;0	43;0	Derbent, Dagestan, Russia
90	Īlāq	99;10	43;20	Angren, Uzbekistan
91	Kāshghar	106;30	44;0	Kashghar, China
[VI] *al-iqlīm shashum* (the sixth climate)				
92	Alān	83;0	44;0	in Dagestan, Russia
93	Nabalūna	42;0	44;0	Naples, Italy
94	Shulakh	100;30	44;0	Chulakkurgan, Kazakhstan
95	Ṭarāz	99;50	44;31	Taraz, Kazakhstan
96	Bīsh Bāligh	111;0	44;50	Pochongtse, Uighur (ruins)
97	Qarāqūrūm	115;0	46;0	Karakorum, Mangolia
98	Khān Bāligh	124;0	46;0	Beijing, China
99	Haraqla	67;20	46;30	Eregli, Turkey
100	Araq	100;0	48;0	
[VII] *al-iqlīm haftum* (the seventh climate)				
101	Akla	108;0	49;0	

	Place Name	L	φ	Identification/Modern name
102	Bulghār	90;0	49;30	(Bulgars)
103	Aqjakirmān	62;0	50;0	Bilhorod-Dnistrovskyi, Ukraine
104	Qirqir	65;30	50;0	in Crimea
105	Mārīkirmān	65;45	50;40	
[+VII]	*khāriz iqlm haftum* (beyond the seventh climate)			
107	Jina Jurābṣūr	68;40	62;0	Hebrides Islands
108	Ṣūdāq	66;0	51;0	Sudak, Crimea

ALIDADE

The uninscribed alidade must be a replacement.

BIBLIOGRAPHY

Pingree 2009, No. 20, pp. 88-93

A103⊙ NORTH-SOUTH ASTROLABE ATTRIBUTABLE TO ḌIYĀ' AL-DĪN

Not dated, 17th century

Diameter 194 mm

London, Victoria & Albert Museum (#809-1889)

Figure A103.1 – Front of the astrolabe with the northern projection of the ecliptic (© Victoria and Albert Museum, London)

Like A090, this astrolabe also consists of a single plate on which the two sides carry the northern and southern projections of the ecliptic respectively along with several star positions. In A090, each side of the plate serves a single latitude, but here

the obverse side is engraved with a double projection for two latitudes and the reverse with a quadruple projection for four latitudes. It is doubtful whether any serious observation can be done with this astrolabe, but the virtuosity exhibited by these complex projections is truly amazing.

Of this astrolabe, only the plate is extant. The rete, alidade and the pin are lost. The *kursī* is very delicately reticulated, with decorative lines engraved on the surface. But the upper part of the *kursī*, most probably a trifoliate finial, is broken and lost. Along with it, the shackle and ring are also missing.

The *kursī* is adorned with a prominent central motif of a tulip with three petals; this is a favourite motif of Ḍiyā’ al-Dīn Muḥammad and occurs in several of his astrolabes.[490] Because of this and because of the fact that this astrolabe carries north-south projections in the same manner as A090, this astrolabe can be attributed to Ḍiyā’ al-Dīn.

OBVERSE SIDE WITH THE NORTHERN PROJECTION OF THE ECLIPTIC

The rim of the astrolabe is divided in 1° and 5° and numbered in 5s clockwise from 5 to 360. The upper half carries the projection for the latitude 36° (Samarqand, or the middle of the fourth climate). The latitude is mentioned under the western end of oblique horizon as *al- ᶜarḍ 36* and the maximum duration of the daylight under the eastern end as *sāᶜāt 14;42*. The lower half is engraved for latitude 32° (Lahore). Here the latitude and the maximum duration are given in the same manner as *al- ᶜarḍ 32* and *sāᶜāt 14;8.*

In both halves are drawn the oblique horizons, altitude circles for every 2° (each fifth highlighted), azimuth arcs for every 10° above the horizon, plain lines for seasonal hours and dotted lines from the western horizon for equal hours. The hour lines related to latitude 36° are drawn in the lower half and those for latitude 32° in the upper half. All these lines are numbered in *abjad.*

490 For example, A067, A071, A076, A082, A084, A085 and A088. A somewhat stylized version of the motif occurs in some other astrolabes like A070 and A080.

Figure A103.2 – Reverse side of the plate with the southern projection of the ecliptic
(@ Victoria and Albert Museum, London)

Upon these is superimposed the ecliptic circle in its northern projection. It is divided, as usual, in the 12 signs and labelled with their names from the vernal equinox onwards in an anti-clockwise direction. Each sign is divided in groups of 6° and numbered from 6 to 30 in the same direction. Single degrees are marked on the edge.

On the entire plate are marked the positions of over 50 stars with dots enclosed in circles and their names are engraved next to their positions.

REVERSE SIDE WITH THE SOUTHERN PROJECTION OF THE ECLIPTIC

As on the obverse side, the rim is divided here also in 1° and 5° and numbered clockwise in 5s from 5 to 360 in *abjad*. On the rim of the upper right quadrant, however, the groups of 5° are numbered once again, but anti-clockwise from the west point to the south point, in common Arabic/Persian numerals from 5 to 90 which are engraved just above the *abjad* numerals. On the rim of the upper left quadrant, the cells are divided in two by diagonal lines. The lower parts of the cells are filled with the *abjad* numerals from 271 to 360 from the east point up to the north point. In the upper part are engraved the common Arabic/Persian numerals from 5 to 90 in the same direction for measuring the angles of altitudes, and once more in *abjad* notation from 5 to 90 in the reverse direction, i.e., from the south point to the east point.

The four quadrants inside these degree scales are designed for four different latitudes, viz. 22° (Mecca), 25° (Medina), 27° (Agra) and 29° (Delhi).

The upper left quadrant carries projections for latitude 29°; here altitude circles are drawn for every 3° (each fifth highlighted) in such a manner that the south point of the plate is also the south point of the projection. The labels *al-ᶜarḍ 29* and *sāᶜāt 13;52,* are engraved above the eastern part of the horizontal diameter.

The upper right quadrant is engraved with the projections for latitude 22°; altitude circles are drawn for every 3° in such a manner that the west point of the plate becomes its south point. The labels *al-ᶜarḍ 22* and *sāᶜāt 13;26* are engraved along the upper half of the vertical diameter.

The lower right quadrant carries the projections for latitude 27°; altitude circles are drawn for every 3°, treating the north point of the plate as the south point of the projection. The labels *al-ᶜarḍ 27* and *sāᶜāt 13;43* are written below the western half of the horizontal diameter.

The lower left quadrant is calibrated for latitude 25°; altitude circles are drawn for every 3°, treating the east point of the plate as its south point. The labels *al-ᶜarḍ 25* and *sāᶜāt 13;35* are written along the lower half of the vertical diameter.

In all the four quadrants azimuth arcs are drawn above the horizon for every 10°; lines for seasonal hours and dotted lines from the western horizon for equal hours are drawn with appropriate orientation. Consequently, the plate looks very cluttered, especially around the centre.

Upon this plethora of projections is superimposed the southern projection of the ecliptic circle. It is divided into the 12 signs and labelled with their names, starting from the vernal equinox and proceeding anti-clockwise. However, the vernal equinox on the reverse side is situated at western intersection of the ecliptic with the equinoctial colure, or horizontal diameter. Each sign is divided in groups of 6° and numbered from 6 to 30 in the same direction. Single degrees are marked on the edge. Here also the positions of over 50 stars are marked with dots enclosed and their names engraved, but with southern orientation.

A104☉ NORTH-SOUTH ASTROLABE ATTRIBUTABLE TO ḌIYĀ’ AL-DĪN[491]

Not dated, 17th century

Diameter 128 mm

Chicago, Adler Planetarium (# L-100)

Figure A104.1 – Front of the astrolabe with the northern rete
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

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491 Entry based on Pingree 2009, no. 19, pp. 82-87; the two star lists have been rearranged according to increasing right ascension. This astrolabe was previously in the Time Museum, Rockford, Illinois, and was described and illustrated in Turner 1985, no. 4, pp. 74-83.

This is one of most ambitious astrolabes produced in the Lahore family. It has an ingenious construction akin to that of A102. While the latter is equipped with limbs on the front and the back, the main body of the present astrolabe consists of just the limb and *kursī* both cast in one piece. The limb carries degrees scales on both sides and accommodates seven plates and a northern rete in the front and a southern rete in the back. In the thickness of the ring, there are slots at the north and south points, so that the tabs on plates can be inserted in either slot. The retes and plates are held in the limb by four rotatable lugs affixed to the limb on each side. Because of these lugs which rise from the surface of the limb, a conventional alidade cannot be used. Therefore, sighting plates with holes are set up on either side of the east-west bar on both the retes. There is a ruler which can be used on either side.

This astrolabe is not signed, nor dated. But Turner has already drawn attention to the fact that it closely resembles five other astrolabes from Lahore, namely A076, A090, A099, A102 and A103. The north-south projections in the retes and in plates, *ghaṭī* scales on the plates, sigmoid curves of the midday altitude of the sun, gazetteer arranged according to climates, the style of the reticulated *kursī* and many other features strongly indicate that it must have been made by Ḍiyā’ al-Dīn.

COMPONENTS

Limb with *kursī* (d. 128, h. 173, t. 28), shackle and chain, 2 retes, 7 plates, ruler, pin and horse.

FRONT

There is no ring, but a chain which may not be original. The shackle is trifoliate in shape. The *kursī* very beautifully reticulated with ornate engravings on the surface. The limb is divided on both sides in 1°, 3° and 6° and numbered clockwise in 6s from 6 to 90 in each quadrant.

Figure A104.2 – The northern rete
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

NORTHERN RETE

The peripheral Capricorn ring and the ecliptic ring are held together by the equinoctial bar which has counter changes at its two intersections with the ecliptic ring. The ecliptic ring is divided in the 12 signs of the zodiac and engraved with their names. Each sign is divided into groups of 6° and numbered from 6 to 30. These groups are further subdivided into single degrees on the edge of the ecliptic ring. Traces of the circles of equator and the Tropic of Cancer are visible. The 38 star pointers are joined by a tracery of leaves or leaf-clusters.

Table A104-1 Stars on the Northern Rete

	Star Name	Identification
1	*Dhanab Qayṭus*	β Ceti
2	*Baṭn*	β Andromedae
3	*Fam Qayṭus*	γ Ceti
4	*Ṣadr Qayṭus*	π Ceti
5	*Ghūl*	β Persei
6	*Kaff al-Jadhmā’*	α Ceti
7	*Tālī Masāfat al-Nahr*	γ Eridani
8	*Dabarān*	α Tauri
9	*ᶜAyyūq*	α Aurigae
10	*Rijl*	β Orionis
11	*Yad Yusra*	γ Orionis
12	*Yad Yumnā*	α Orionis
13	*Rijl Yumnā*	κ Orionis
14	*Shiᶜrā Yamānī*	α Canis Majoris
15	*Shiᶜrā Shāmī*	α Canis Minoris
16	*Ṭarfat al-Safīna*	ρ Puppis
17	*Fard Shujāᶜ*	α Hydrae
18	*Qā’idat al-Bāṭiya*	α Crateris
19	*ᶜAnāq*	ζ Ursae Majoris
20	*Janāḥ Ghurāb*	γ Corvi
21	*Simāk Aᶜzal*	α Virginis
22	*Simāk Rāmiḥ*	α Bootis
23	*Nayyir Fakka*	α Coronae Borealis
24	*ᶜUnuq Ḥayya*	α Serpentis

	Star Name	Identification
25	*Rās al-Jāthī*	α Herculis
26	*Rās al-Ḥawwā’*	α Ophiuchi
27	*ᶜAyn Tinnīn*	α Draconis
28	*Yad Ḥawwā’*	δ Ophiuchi
29	*Wāqiᶜ*	α Lyrae
30	*Minqār Dajāja*	β Cygni
31	*Nasr Tā’ir*	α Aquilae
32	*Dhanab al-Dulfīn*	ε Delphini
33	*Dhanab al-Dajāja*	α Cygni
34	*Fam Faras*	ε Pegasi
35	*Dhanab al-Jadī*	α Capricorni
36	*Sāq Sākib al-Mā’*	δ Aquarii
37	*Surrat Faras*	δ Pegasi
38	*Mankib Faras*	β Pegasi

Figure A104.3 – The southern rete
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

SOUTHERN RETE

In the southern rete, the Tropic of Cancer passes through the peripheral ring. This Cancer ring and equinoctial ring are held together by the equinoctial bar which has a counter change at the centre. The upper half of the solstitial bar is also represented. As in the northern rete, the ecliptic ring here is divided into the 12 signs of the zodiac and engraved with their names and each sign is divided into 6° and 1°. However, in this southern rete, the signs commence at the west point and proceed anti-clockwise. Likewise the right ascension of the stars also increases anti-clockwise.

The upper half of the solstitial bar is engraved with a declination scale, such as normally to be found on the alidade. On the surface of the bar, 6 divisions are created

and each of these is marked with the serial numbers of a pair of signs. Each of these divisions is subdivided (somewhat unevenly) into 6 units on the edge.

The 26 stars marked on the rete are listed below, starting from the west point and proceeding anti-clockwise in the order of increasing right ascension.

Table A104-2 Stars on the Southern Rete

	Star Name	identification
1	*Dhanab Qayṭus J[anūbī]*	β Ceti
2	*Muqaddam*	β Arietis
3	*Mu'akkhir Sharaṭayn*	γ Arietis
4	*Ṣadr Qayṭus*	π Ceti
5	*Tālī Masāfat Nahr*	γ Eridani
6	*Rijl*	β Orionis
7	*Yad Yumnā*	α Orionis
8	*Rijl yumna*	κ Orionis
9	*Shiᶜrā Shāmī*	α Canis Minoris
10	*Ṭarfat Safīna*	ρ Puppis
11	*Fard al-Shujāᶜ*	α Hydrae
12	*Qāᶜidat al-Bāṭiya*	α Crateris
13	*Ṣarfa*	β Leonis
14	*Simāk Rāmiḥ*	α Bootis
15	*Kiffa Sh[amālī]*	β Librae
16	*ᶜUnuq al-Ḥayya*	α Serpentis
17	*Rukbat Ḥawwā' Yasra*	ζ Ophiuchi
18	*Rās al-Jāthī*	α Herculis
19	*Rās al-Ḥawwā'*	α Ophiuchi
20	*Yad al-Ḥawwā Yumnā*	δ Ophiuchi

	Star Name	identification
21	*ᶜIsbāt al-Rāmiḥ*	ρ Sagittarii (?)
22	*Nasr Ṭā’ir*	α Aquilae
23	*Qarn al-Jadī al-Thānī*	β Capricorni
24	*Fam Faras*	ε Pegasi
25	*Mankib Sāk Sākib*	α Aquarii
26	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti

PLATES

There are seven plates. The first four are calibrated for specific latitudes. The fifth plate carries on both sides combined projections for two latitudes each. Some of the plate faces carry northern projections and some others southern projections. In the following table, the northern and southern projections are listed separately. The sixth plate is engraved with the tablet of ecliptic coordinates on the obverse side and with the tablet of horizons on the reverse. The last plate carries what is normally engraved on the mater, namely a geographical gazetteer on the obverse and the trigonometric quadrant, the zodiac quadrant, the shadow squares and astrological tables on the reverse side.

Table A104-3 Plates

	φ	Maximum duration of daylight	
		hours	*ghaṭī*
4a	11° N	12;48	---
1a	19° N	---	---
3a	27° N	---	34
4b	29° N	---	---
2a	32° N	---	35
1b	22° S	---	34

	φ	Maximum duration of daylight hours	ghaṭī
3b	36° S	---	35
2b	40° S	---	36.6
5a	0° + 30° S		
5b	34° S 38° S	14;26 14;42	
6a	Tablet of ecliptic coordinates		
6b	Tablet of horizons		
7a	Geographical gazetteer		
7b	What is usually on the back of the astrolabe		

Plates 1-4 carry altitude circles for every 2°, with each third one dotted, and azimuth arcs for every 10° above the horizon. There are lines for seasonal hours numbered from 1 to 12 from the western horizon onwards. The lines for equal hours vary considerably. On 1a (19° N), 2a (32° N), 2b (40° S), 3a (27° N), 3b (36° S) dotted lines for equal hours are drawn from the western horizon. Each hour is then divided by plain lines in five parts of 12° minutes each. Two of these parts constitute a *ghaṭī.* These *ghaṭīs* are numbered serially from the western horizon onwards.

On 1b (11° N) these lines for equal hours and for 12° minutes are drawn from both the western and eastern horizons. Here the *ghaṭīs* are numbered from 1 to 14 from each horizon up to the meridian.

On 4b (29° N) there are dotted lines for equal hours and plain lines for *ghaṭīs* drawn from the western horizon. The *ghaṭīs* are numbered serially from the western horizon onwards.

On 4a (11° N) dotted lines for equal hours and plain lines for *ghaṭīs* are drawn from both the eastern and western horizons and counted from both the horizons; the hours are numbered in *abjad* from 1 to 7 from each horizon up to the meridian; the *ghaṭīs* are numbered in common Arabic/Persian numerals from 1 to 16 from each horizon up to the meridian.

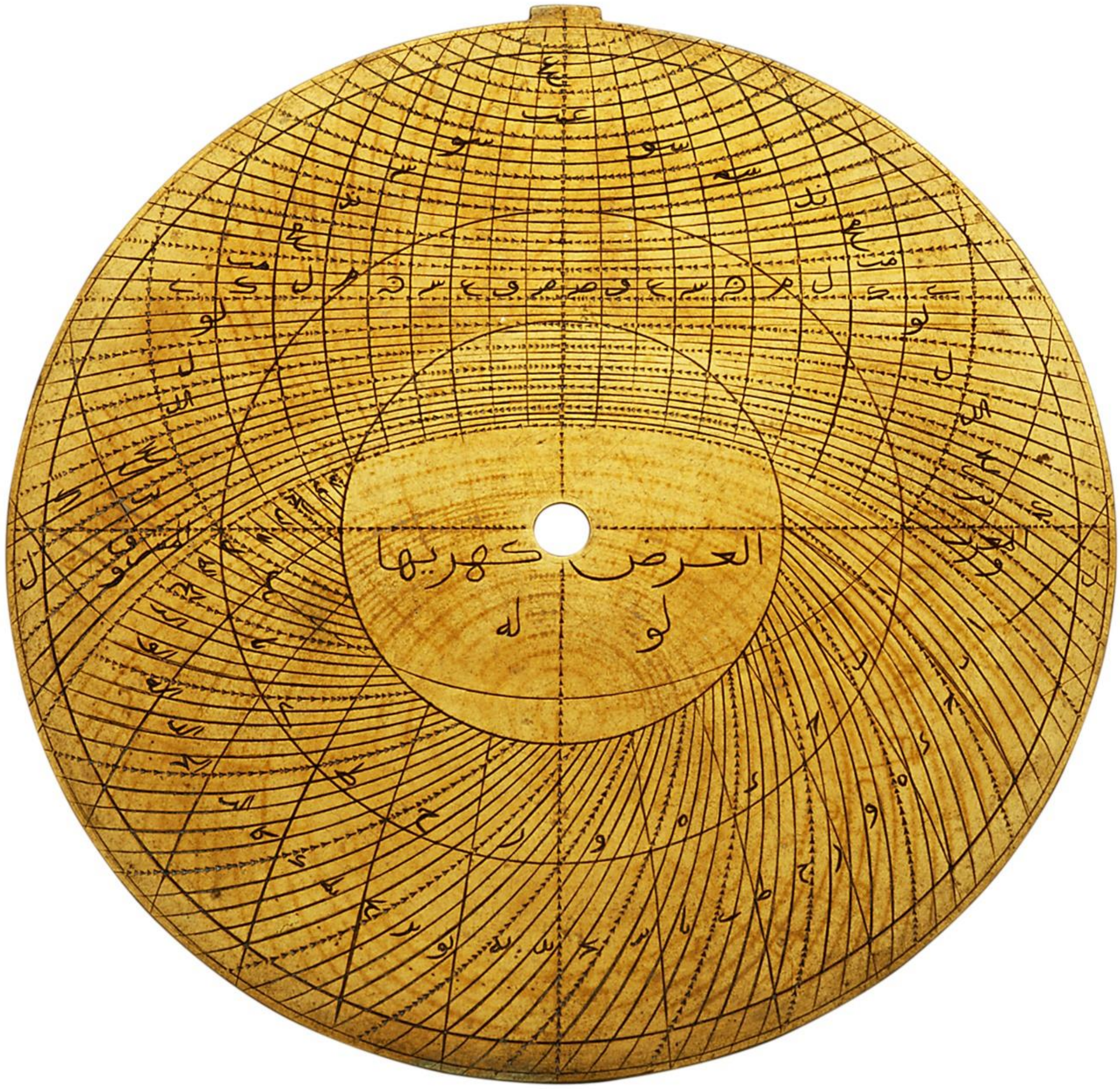

Figure A104.4 – Plate 3b with southern projection for latitude 36°.
Note the dotted lines for equal hours and plain lines for ½ *ghaṭīs*
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

Surprisingly there is great laxity in engraving the labels mentioning the latitude and the maximum duration at that latitude. While the latitude is mentioned in all cases, the other parameter is not. Only in one case (4a for 11° N) the duration is mentioned in hours and minutes together with the argument: *sā*ᶜ*āt* 12;48. On 1a (19° N) the argument *sā*ᶜ*āt* is engraved without the actual value. As can be seen from the table above, the maximum duration is given in *ghaṭīs* and *palas* in 5 cases. The engraver had difficulty in transliterating the term *ghaṭī* (or *ghaḍ/rī* as it is commonly pronounced) in Persian/Arabic script; sometimes *karī-hā* and some other times *kahrī-hā,* with two different types of glyphs for ‘h’, ‘-*hā’* being the plural suffix.

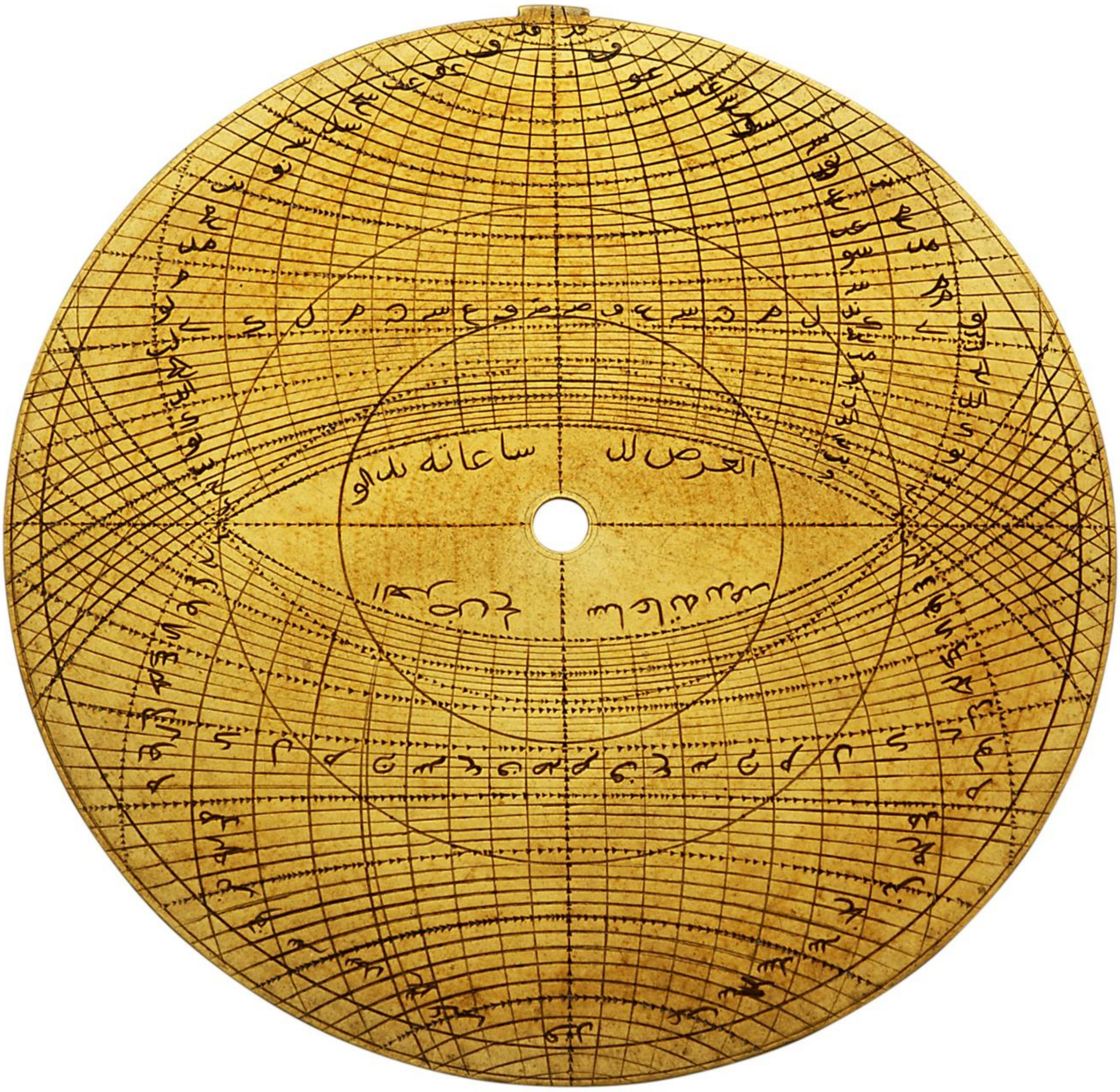

Figure A104.5 – Plate 5b with double projection of latitudes 34° S and 38° S
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

Plate 5 has double projections of latitudes 0° and 30° on the obverse and of 34° and 38° on the reverse, with altitude circles for every 3° and azimuth arcs for every 10° above the horizon. On the obverse side, under the projection for 0° is engraved *lā ᶜarḍ lahu* (there is no altitude). Under the projection for 30° there is an incomplete label (*ᶜarḍ 30 sāᶜāt*) which omits the maximum duration. On the reverse side, however, the two latitudes receive full labels *ᶜarḍ 34 sāᶜāt 14;26* and *ᶜarḍ 38 sāᶜāt 14;42.*

Plate 6 has the tablet of ecliptic coordinates on the obverse and the tablet of horizons on the reverse, the former with the usual label and the latter without.

Figure A104.6 – Plate 7a with the geographical gazetteer
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

Geographical Gazetteer

On 7a is engraved a geographical gazetteer in three circles providing the names, longitudes and latitudes of 77 localities, arranged according to climates.[492]

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492 There are some misreadings in Pingree 2009, p. 87. These are mentioned with the prefix ‘P’ in brackets after the relevant entry.

Table A104-4 Geographical Gazetteer

	Place Name	L	φ	
	Outer Circle			
[-I] *az khaṭṭ istiwā tā iqlīm awwal* (from the line of equator up to the first climate)				
01	Jazīra Qanbala	21;0	3;0	
02	Jamkūt	170;0	5;0	
03	Shalā	180;0	5;0	
04	Ghānā[493]	19;0	10;0	
05	ᶜAdan	76;0	11;0	
06	Sarāndīb	130;0	10;0	
[I] *mabdā iqlīm awwal 12;48* (beginning of the first climate [at latitude] 12;48°)				
07	Jubil	75;0	13;30	
08	Janad	75;30	14;30	
09	Burhānbūr	103;0	20;30	
10	Junīr	110;5	19;48	(P 108;0)
11	Tānah	114;5	19;20	(P 104)
12	Juyūl	106;40	19;0	
13	Bījābūr	105;30	17;20	(P 104;30 17;10)
14	Dawlatābād	111;5	20;30	(P 102;0)
[II] *mabdā iqlīm dūyum 20;31* (beginning of the second climate [at latitude] 20;31°)				
15	Tā’if	77;30	21;20	(P in climate I)
16	Makka Musharraf	77;10	21;40	

493 The entries of this and the next place are mixed up in Pingree 2009, p. 87.

	Place Name	L	φ	
17	Madīnat Ṭayyiba	75;20	25;0	
18	Hurmūz	92;0	25;0	
19	Akabarābād	114;0	26;43	
20	Qannawj	115;50	26;35	(P Ganawj)
21	Ajmīr	111;5	26;0	(P 111)
22	Kwāliyar	114;0	26;29	
23	Lahknaw	114;53	26;30	
24	Jawnbūr	119;6	36;36	(read: 26;36)
25	Awadh	118;6	27;22	
26	Balāwan	119;59	27;22	(read Badāwan)
27	Banāras	107;20	26;55	(P 117;20 26;15)
28	Aḥmadābād	108;40	23;15	
29	Kanbāyat	109;20	22;20	
[III] *mabdā iqlīm siwum 27;34* (beginning of the third climate [at latitude] 27;34°)				
30	Kūlkanda	114;19	28;4	(read: 18;4)
31	Firūzābād	87;30	28;10	
32	Dihlī	113;35	28;39	
33	Hānsī	112;25	29;45	(P 28;45)
34	Bānībahtah	113;20	28;52	
35	Baran	114;5	28;48	
36	Multān	107;35	29;40	
37	Shīrāz	108;0	29;16	(read 88;0)
38	Baṣra	84;0	30;0	

	Place Name	L	φ	
39	Kirmān	91;30	30;5	
	Middle Circle			
40	Tahānīsar	112;33	30;10	(P 112;13)
41	Miṣr	66;30	30;20	
42	Sunām	112;25	82	(read latitude 30;30)
43	Parshūr	85;55	31;0	(read 105;55)
44	Kūfa	79;30	31;30	
45	Qayrawān	41;0	31;40	
46	Bayt al-Maqdis	66;30	31;50	
47	Lāhūr	109;20	31;50	
48	Yazd	89;0	32;0	
49	Iṣfahān	87;40	32;25	(P 81;40)
50	Qandahār	107;40	33;0	
51	Baghdād	82;0	33;25	
[IV] *mabdā iqlīm chahārum 33;43* (beginning of the fourth climate [at latitude] 33;43°)				
52	Kāshān	86;0	34;0	
53	Harāt	94;20	34;30	(P 62;10 34;20)
54	Sāwa	85;0	35;0	
55	Kashmīr	108;0	35;0	
56	Ḥalab	72;10	35;50	
57	Mashhad	92;30	36;0	
58	Balkh	101;0	36;11	(P 36;51)
59	Marāgha	82;0	37;20	

	Place Name	L	φ	
[V] *mabdā iqlīm panjum 39;1* (beginning of the fifth climate [at latitude] 39;1°)				
60	Samarqand	99;19	39;37	
61	Bukhārā	97;30	39;50	
62	Tubbat	110;0	40;0	
	Inner Circle			
63	Khutan	107;0	42;0	(P 101;0)
64	Farghāna	102;0	42	
65	Īlāq	99;0	43;20	(P 99;30 43;6)
66	Khujand	97;45	43;30	
[VI] *mabdā iqlīm shashum 43;30* (beginning of the sixth climate [at latitude] 43;30°)				
67	Kāshghar	106;30	44;0	
68	Alān	43;0	44;0	(P ‘read 73;0’)
69	Bīsh Bāligh	111;0	45;50	
70	Khān Bāligh	124;46	46;0	
71	Harqala	67;20	46;30	
[VII] *mabdā iqlīm haftum 47;30* (beginning of the seventh climate [at latitude] 47;30°)				
72	Araq	105;0	48;0	(P 85;0)
73	Akla	88;0	49;0	(P 108;0)
74	Qirqir	65;30	50	
[+VII] *khāriz iqlīm haftum* (beyond the seventh climate)				
75	Marīkirmān	64;45	50;40	
76	Jazīra Fard	---	64;41	
77	Ṣūdāq	66;0	51;0	

Place Name	L	φ

Figure A104.7 – Plate 7b to be used as the back of the astrolabe
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

BACK

There is no back as such in this astrolabe; its function is discharged by the reverse side of plate 7, where the various elements are arranged somewhat differently from the usual backs of astrolabes. Here the lower half contains six semi-circular rows. Reading from the outside, these contain successively the names of the 28 lunar mansions, the names of the 12 zodiac signs, the planetary lords of the terms (indicated by the final

letters of their names), the degrees in each term, cotangent scales in feet and digits and their subdivisions. These rows are extended into the upper half, where they remain completely blank. Then follows a circular row carrying in each quadrant altitude scales, divided in 6° and 1°, and numbered from 6 to 90. Inside this altitude scale, the upper half is occupied by a double solar quadrant with declination arcs for 5° of solar longitude, with each third arc dotted. The serial numbers of the relevant signs are written along the horizontal diameter; 8, 7, 6, 5, 4, 3 from the periphery in the east up to the centre (i.e., from winter solstice to summer solstice) and 2, 1, 0, 11, 10, 9 from the centre up to the periphery in the west (i.e. from summer solstice to winter solstice). The declination arcs are also numbered along the vertical radius, but all the numbers are not clearly visible in the available photo.

On the quadrant on the right are drawn three sigmoid curves of the midday altitude of the sun at latitudes 19°, 27° and 32°. There are no labels with these curves, merely the latitude values are engraved.

In the lower left quadrant are engraved two shadow squares, one inside the other. The outer one is for 12 digits and the inner one for 7 feet. They are accompanied by the usual labels. In the lower right is the trigonometric quadrant with 30 vertical parallels, each third line is dotted.

Figure A104.8 – Graduated ruler
Photograph by Stephen Pitkin, Pitkin Studio. Image © Adler Planetarium, Chicago, IL.

RULER

There is no alidade; instead each of the retes is equipped with sights at the two ends of its equinoctial bar. There is a graduated ruler with ornate ends which can be used on either side. Each of its arms is divided in 6 units. These units are engraved with *abjad* numbers in two registers as shown below. But the significance of these numbers eludes us.

40 64	42	12	20	?	45	?	42	12	22	8?	10
42	26	24	31	18	32	48	29	24	18	42	65

PROVENANCE

This astrolabe was previously with the Time Museum, Rockford, Illinois.

BIBLIOGRAPHY

Pingree 2009, No. 19, pp. 82-93; Turner 1985, no. 4, pp. 74-83.

ḤĀMID

Ḥāmid ibn Muḥammad Muqīm (*fl.* 1655-1691) belongs to the fourth generation of the Lahore family of instrument makers. He is known though 11 astrolabes and 3 celestial globes produced between August 1655 and June 1691.[494] In an astrolabe preserved in the Houghton Library of the Harvard University, the year of production is engraved as 1038 (= AD 1628-29). But this year is too early for Ḥāmid's work since his own father's Muḥammad Muqīm's instruments begin to appear only from AH 1031/ AD 1021-22. Therefore, the year on the astrolabe at the Houghton Library must have been wrongly inscribed as 1038 instead of 1068.

Apart from producing astrolabes and celestial globes, Ḥāmid also copied a manuscript of Naṣīr al-Dīn al-Ṭūsī's highly popular manual on the astrolabe entitled *Bist Bāb* on 10 Sha'bān 1087 (=17 September 1678).[495]

Ḥāmid's astrolabes are relatively small, with diameters ranging between 77 and 142 mm, and they lack the elegance of the astrolabes crafted by his father Muḥammad Muqīm and by his elder cousin Ḍiyā' al-Dīn. Ḥāmid attempts to make his mark in other respects. The most remarkable of these is that, in 10 out of the 14 instruments which bear his signature, he mentions the precise date (*tārīkh*) and month (*shahr*), besides the year of production.

We have seen that in his gazetteers, Allāhdād wished to provide *inḥirāf* along with longitudes and latitudes, but failed to do so, and that thereafter Allāhdād's descendants limited their gazetteers to just longitudes and latitudes. Ḥāmid tries to revive this older tradition and gives *inḥirāf* and *jihat,* in addition to longitudes and latitudes in some of his astrolabes (A112 - A116, A119).

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494 His three globes are dated 1655 (Cambridge, Whipple Museum), 1682 (Hyderabad, Salar Jung Museum) and 1690 (Pune, Kelkar Museum). Their full descriptions will appear in section F.

495 Cf. *Catalogue of the Persian Manuscripts in the Salar Jung Museum and Library, Hyderabad*, Vol. IX, Hyderabad 1988, Ms. no. 3877: *Bist Bāb*, with an anonymous commentary, copied by Ḥāmid Aṣṭurlābī ibn Muḥammad Muqīm on 10 Sha'bān 1087/17 September 1678. While showing me the manuscript, Dr Rahmat Ali Khan, the then Keeper of Manuscripts, Salar Jung Museum, remarked about the particularly poor calligraphy of Ḥāmid.

In the Lahore astrolabes, the arcs of declination are drawn at equal spaces in the solar quadrants at the back. Ḥāmid follows this family tradition in some of his astrolabes, but in others, he projects them stereographically as is done in Safavid astrolabes. In drawing the graphs of the midday altitude of the sun in all seasons (*khaṭṭ niṣf al-nahār*), he gives greater importance to the latitude of Mecca (at 20° or 21°) than to the latitudes of Lahore, Agra and Delhi.

The most remarkable piece of his work is the highly complex and massive astrolabe and qibla-indicator which he completed on 6 December 1686. It is constructed like a round casket in which are stacked the rete and seven plates. Five of these plates are calibrated for different latitudes, but inside the circle of Cancer on each plate are drawn lines radiating from the centre, indicating the azimuths of *qibla* of certain places with their names. The remaining two plates are exclusively devoted to *qibla*-lines from various localities. A very elaborate set of astrological tables is engraved on the back . The geographical gazetteer is engraved on the inner side of the lid, providing the longitude, latitude, the *inḥiraf* or the azimuth of qibla, and *jihat* for 142 localities. This and other gazetteers of Ḥāmid contain names of several Indian cities for the first time, such as Rajmahal and Gaur in Bengal, Bandar Sūrat (the seaport of Sūrat) in Gujarat and Gulbarga in Karnataka.

Apparently, this instrument was meant as presentation piece for some high noble at the Mughal court whose name must have been engraved on the front side of the *kursī.* About a hundred years later, a new owner got the original erased and had his name engraved at the apex of the upper right quadrant on the back as Mālik Qadirdād Khān Muhandis 1186 sanah (owner Qadirdād Khān, engineer/technician, AD 1772-73).

A105⊙ ASTROLABE BY ḤĀMID, AH 1068 (AD 1657)

2 Muharram 1068 = 9 October 1657

Diameter 131 mm

London, Nasser D. Khalili Collection of Islamic Art (SCI 13)

Figure A105.1 – Front of the astrolabe (photo by S. R. Sarma)

COMPONENTS

Body with *kursī* (d. 131, h. 170, t. 1), shackle and ring, rete for 38 stars, 5 plates, uninscribed alidade, washer, pin and horse.

FRONT

Large ring, trifoliate shackle, *kursī* pierced with an elaborate symmetric pattern, trifoliate finial. The limb is divided in 1° and 6° and labelled from 6 to 90, separately in each quadrant.

RETE

The equator is not represented in the rete. The two rings of the Capricorn and ecliptic are held together by the complete equinoctial bar (with counter changes at its intersections with the ecliptic ring) and by the almost complete solstitial bar, which is interrupted by two heart-shaped ornaments, on either side of the equinoctial bar.

Figure A105.2 – Rete of the astrolabe (photo by S. R. Sarma)

The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names. Each sign is divided into groups of 6° and numbered accordingly from 6 to 30. The sloped edge of the ecliptic ring is graduated in 3°.

There is an arch-shaped Capricorn index (*al-mūrī*). A handle was provided in the outer ring at about 140° NW, but it got detached and there remains the just the hole where it was affixed.

The star pointers are generally shaped like tiger's claws; in two cases, Ḥāmid shapes them like the petals of tulip flowers, following the style of his father Muqīm. The star ι Ceti is placed in the lower half, just above β Ceti, both in the sign Aries. Star names are often abbreviated.

Table A105-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
2	*Dhanab al-Qayṭus Janūbī*	β Ceti
3	*Baṭn al-Ḥūt*	β Andromedae
4	*Rijl al-Musalsala*	γ Andromedae
5	*Fam al-Qayṭus*	γ Ceti
6	*Ṣadr al-Qayṭus*	π Ceti
7	*Rās al-Ghūl*	β Perse
8	*Kaff al-Jadhmā'*	α Cet
9	*Tālī Masāfat al-Nahr*	γ Eridani
10	*ᶜAyn al-Thawr*	α Tauri
11	*ᶜAyyūq*	α Aurigae
12	*Rijl al-Jawzā' [al-]Yusrā*	β Orionis
13	*Yad al-Jawzā' [al-Yusrā]*	γ Orionis
14	*Yad al-Jawzā' [al-Yumnā]*	α Orionis
15	*Rijl al-Jawzā' [al-]Yumnā*	κ Orionis
16	*Shiᶜrā Yamānī*	α Canis Majoris
17	*Shiᶜrā [Shāmī]*	α Canis Minoris
18	*Ṭarfat al-Safīna*	ρ Puppis
19	*Minkhar al-Shujāᶜ*	σ Hydrae
20	*Fard al-Shujāᶜ*	α Hydrae
21	*[Qāᶜidat] al-Bāṭiya*	α Crateris
22	*Janāḥ al-Ghurāb*	γ Corvi
23	*[Simāk] Aᶜzal*	α Virginis

	Star Name	Identification
24	*Simāk Rāmiḥ*	α Bootis
25	*Nayyir Fakka*	α Coronae Borealis
26	*ᶜUnuq al-Ḥayya*	α Serpentis
27	*Qalb al-ᶜAqrab*	α Scorpii
28	*Rās al-Jāthī*	α Herculis
29	*Yad al-Ḥawwā' [al-Yumnā] al-Muqaddam*	δ Ophiuchi
30	*Nasr Wāqīᶜ*	α Lyrae
31	*Nasr Ṭā'ir*	α Aquilae
32	*Dhanab al-Dulfīn*	ε Delphini
33	*Dhanab al-Dajāja*	α Cygni
34	*Fam al-Faras*	ε Pegasi
35	*Dhanab al-Jadī*	δ Capricorni
36	*Sāq Sākib al-Mā' J[anūbī]*	δ Aquarii
37	*Surrat al-Faras*	δ Pegasi
38	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are 5 plates. The duration of the longest day is given in hours, minutes and seconds, but there are inconsistencies in the first two entries.

Table A105-2 Plates

	φ	Longest day
1a	21°	13;36,56 hours
1b	22°	13;20,56 hours!
2a	25°	13;33,36 hours

	φ	Longest day
2b	27°	13;42,46 hours
3a	32°	14;8,0 hours
3b	36°	14;27,10 hours
4a	18°	13;3,56 hours
4b	0°+72°+90°	
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons with the label *safīḥa āfāqī*	

Surprisingly there is no plate for Delhi. On plates 1 to 4a, altitude circles are drawn for every 3°, with every fifth circle dotted. Azimuth arcs are drawn for every 6° below the horizon and numbered in a straight line. Plain lines for seasonal hours and dotted lines for equal hours counted from the western horizon. Under the western horizon *al-maghrib* and under the eastern horizon *al-mashriq.*

Plate 4b contains a combined projection for the latitudes of 0°, 72° and 90° with the labels *lā ᶜarḍ lah, li ᶜarḍ 72* and *li ᶜarḍ tisᶜūn* respectively.

Plate 5 is engraved with the tablet of ecliptic coordinates on the obverse and with the tablet of horizons on the reverse.

Geographical Gazetteer

The gazetteer is engraved in two concentric circles for 38 localities with their longitudes and latitudes. In the outer circle the tops of the letters are towards the centre; in the inner circle they are towards the circumference of the astrolabe.

Figure A105.3 – Geographical Gazetteer (photo by S. R. Sarma)

Table A105-3 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		

	Place Name	L	φ
1	Makka Mu^caẓẓam	77;10	21;40
2	Madīnat Rasūl ^cAlīyat al-Salām	75;20	24;50
3	Ṭā^cif	77;30	21;20
4	^cAdan	76;0	11;0
5	Jidda	76;0	21;0
6	Bayt al-Maqdis	66;30	31;50
7	Miṣr	63;0	30;20
8	Kūfa	79;30	31;30
9	Baghdād	80;15	33;20
10	Madā'in	80;20	33;0
11	Iṣfahān	86;40	34;25
12	Shīrāz	88;0	29;0
13	Multān	107;35	29;30
14	Lāhūr	109;20	31;50
15	Bust	100;0	33;0
16	Qandahār	107;40	33;0
17	Akra	115;4	26;43
18	Dihlī	113;18	28;13
19	Hamadān	103;0	36;8
20	Badakhshān	104;25	36;10
21	Balkh	101;0	36;41
22	Kābul	104;40	34;30
23	Kashmīr	105;0	35;0
24	Ṭūs	92;30	36;0

	Place Name	L	φ
25	Bukhārā	96;30	39;10
26	Samarqand	99;0	40;0
27	Tubbat	110;0	40;0
	Inner Circle		
28	Dawlatābād	111;0	20;30
29	Pījāpūr	114;20	17;17
30	Kūlkand	114;19	18;4
31	Burhānpūr	112;0	21;21
32	Janīr[496]	110;0	18;48
33	Kanbāyat	109;20	22;20
34	Lakhnaw	114;13	26;30
35	Kawāliyār	114;0	26;29
36	Bānāras	117;20	26;15
37	Jawnpūr	119;6	26;30
38	Ajmīr	111;5	26;0

BACK

The rim of the upper half bears the altitude scales divided in 1° and 6° and labelled 6—90; 90—6. In the upper left is a trigonometric quadrant with 60 horizontal parallels. In the upper right quadrant are drawn six declination arcs, labelled along the vertical and horizontal diameters with the serial numbers of the signs from 0 to 11. Three graphs of solar meridian altitude for the latitudes 20° (Mecca?), 27° (Agra) and 32° (Lahore),

[496] This locality is mentioned also in the next three astrolabes (A106, A107and A108) with the same coordinates. It ought to be in south India, but cannot be identified

with labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 20*, *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ 32.*

In the lower half, there are shadow squares, on the left for a base of 12 and on the right for a base of 7 with the usual labels.

Inside the shadow squares is a table of triplicities. Outside the shadow squares are two semi-circular tables that show the correlation between the 28 lunar mansions and the 12 signs of the zodiac. The rim of the lower half bears the cotangent scales.

Figure A105.4 – Back of the astrolabe (photo by S. R. Sarma)

ALIDADE

The alidade has ornate ends and an ornate centre-piece, but is without any graduations or labels.

Figure A105.5 – Signature of the Astrolabe Maker (photo by S. R. Sarma)

INSCRIPTION

Below the shadow squares is the maker's signature which is continued on the left and right of the shadow squares:

> *ṣanah qalīl al-ᶜibād ḥāmid ibn muḥammad muqīm ibn ᶜīsā*
> *ibn allāhdād asṭurlābī lāhūri humāyūnī*
> *fī al-tārīkh 2 shahar muharram*
> *fī sanah 1068 hijrī.*
>
> 'Made by the least of the servants [of God], Ḥāmid, son of Muḥammad Muqīm, son of ᶜĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, on the date 2 in the month of Muharram in the year 1068 of the Hijra.'

The date translates to 9 October 1657.[497]

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497 Khalili catalogue gives 10 October.

A106⊙ ASTROLABE BY ḤĀMID, 1038 AH (AD 1628-1629)!

Diameter 125 mm

Cambridge, Mass., Harvard University, Houghton Library (552-1)

Figure A106.1 – Front of the astrolabe (photo courtesy Professor Owen Gingerich)

In a heart-shaped cartouche on the back, the year of manufacture is clearly engraved as *sanah 1038*. The era is not mentioned, but it can be assumed that it is the Hijri era; this would correspond to AD 1628-29. This year is problematic, because this is just about the time when his father Muḥammad Muqīm began producing astrolabes (his first extant one is dated 1621). Moreover, the next extant astrolabe by Ḥāmid is dated 1657, with a gap of almost 30 years! The Répertoire accepts this early date and exclaims that Ḥāmid was active until his mid-eighties.[498] But this cannot explain the long gap of about 30 years.

Figure A106.2 – Detail of Figure A106.5

It is possible that (i) he made here a mistake, just as he did in the spelling of his great grandfather's name and in certain *abjad* numbers on the rim of the front of the

498 The Répertoire writes: "Of this son of Muḥammad Muqīm, the brother of the Jamāl al-Dīn, there exist 9 instruments, 8 of which are dated: and all are dated to a precise day and not only to a running year as is the common usage. These dates are distributed from AH 1038 to AH 1102, that is to say from 1628/29 to 1691 AD. The earliest extant instrument is dated 1038: it shows an ornamentation quite remarkable, even a bit too affected. One is inclined to imagine a major work of apprenticeship composed under the vigilant eyes of Muḥammad Muqīm himself. Towards the end of his life, Ḥāmid has a style more hasty, his handwriting is less careful. But if the astrolabe no. 1 has been put together by a young man of say 18 years in AH 1038 = AD 1628-29, astrolabe no. 8 has been made by a man of 83 or 84 years!

astrolabe; or (ii) that the date was added by somebody later on, or (iii) that the whole thing was a forgery because of all the three reasons mentioned in (i). However, the astrolabe is too good to be a forgery. I am inclined think that these three cases should be attributed to certain carelessness on the part of Ḥāmid.

It is obvious that the engraver made a mistake in writing 1038 (١٠٣٨) instead of the correct year 1068 (١٠٦٨), for in all probability the astrolabe was made in AH 1068= AD 1657-58. Moreover, the present astrolabe contains several errors in the *abjad* symbols with which the degree scale on the limb is numbered. The calligraphy is rather poor.

Stylistically this astrolabe has similarities with A109 of 1661. The *kursī,* worked *à jour,* resembles those of A109 and A110. The surface decorations on the empty spaces between legends on the front, more particularly on the back, are reminiscent of Safavid astrolabes.

COMPONENTS

Body with *kursī* (d. 125, h. 167, t. 4.5), shackle and ring, rete (d. 109) for 40 stars, 4 plates, alidade (114 x 10) and pin. The horse is missing.

FRONT

The *kursī* and the limb are cast in one piece to which the back plate has been joined by rivets along the circumference. Inside the limb the plug has been added and hammered in. At the back there is a faint impression of the rectangular plug. The *kursī* is pierced, producing an unimpressive pattern with a small cartouche in the middle, on which is engraved *allāhu akbar*. There is a trifoliate finial to which the shackle (also trifoliate in shape) has been attached. Through the shackle passes the ring with a flat hexagonal cross section. In the front the points where the *kursī* is joined to the main body appears to be slightly damaged.

The limb is not perfectly circular, but made up of 60 lobes. Each lobe is designed as an oval cartouche in which the *abjad* numbers of the degree scale are engraved. Besides the *abjad* symbols, some decorative lines are also drawn in each oval. The limb is graduated in 1° and 6° and labelled from 6 to 90 separately in each quadrant. However, there are many errors in the *abjad* numerals (underlined below). The numbers, read clockwise from the south point onwards, are as follows:

26	12	75	24	30	36	42	48	54	60	66	72	78	84	90;
96	12	18	24	30	36	42	48	54	60	66	72	78	84	90;
6	22	18	24	29	36	42	48	54	60	66	72	78	84	90;
6	19	18	24	30	36	42	48	54	60	66	72	75	84	25.

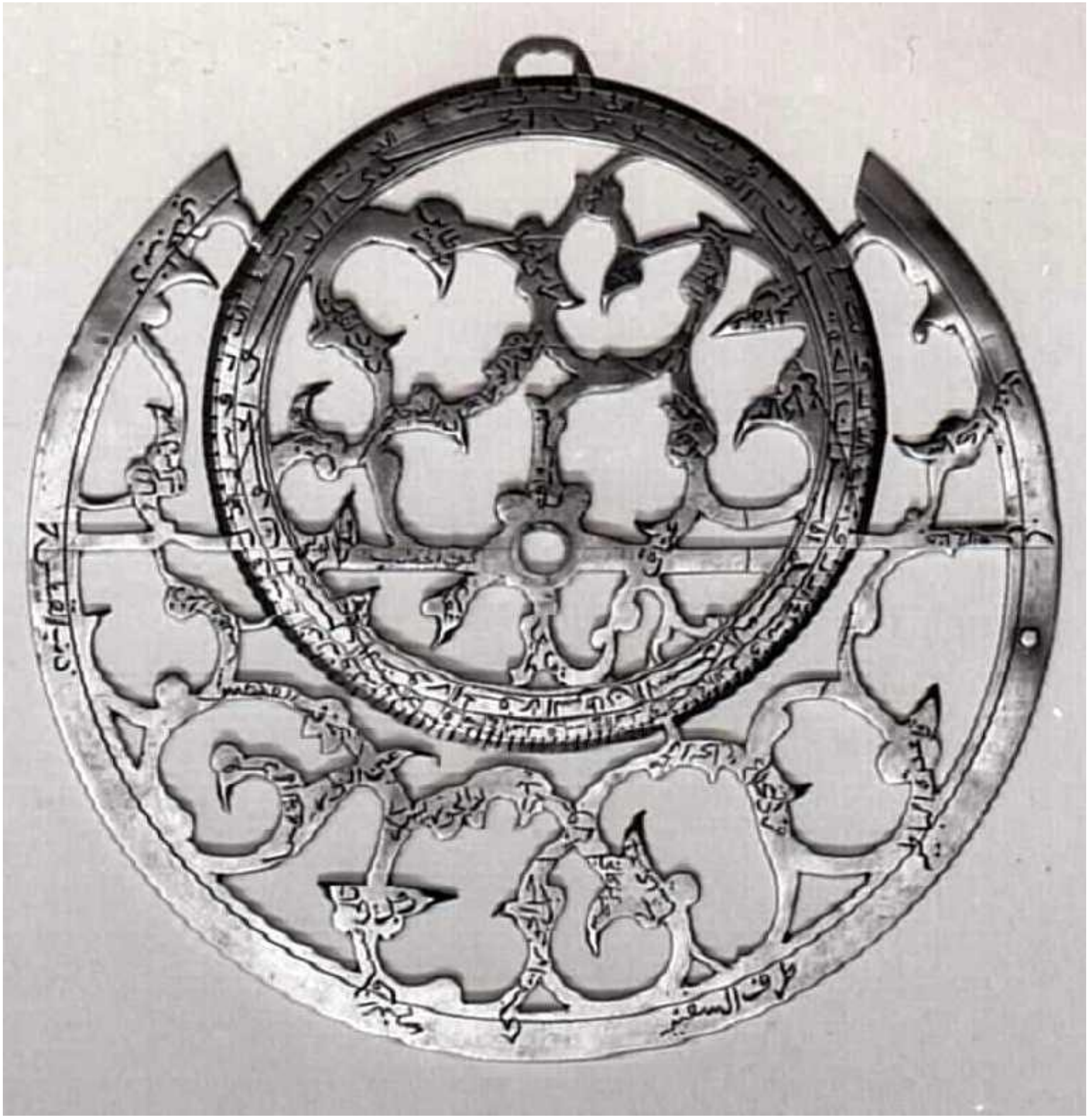

Figure A106.3 – Rete of the astrolabe (photo courtesy Professor Owen Gingerich)

RETE

The two rings of the Capricorn and of the ecliptic are held together by the equinoctial bar which has counter changes at its two intersections with the ecliptic ring. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names.

Each sign is divided into units of 6° and numbered 6, 12, 18, 24, 30; here the division marks are not clearly engraved; one sees just the numbers. The sloped edge of the ecliptic ring is divided into units of 3°. The *mūrī* is shaped like a thin arch. In the outer ring, just below the west point, there is a handle to rotate the rete.

The 40 star pointers are generally shaped like tiger's claws. Outside the ecliptic, the star pointers are joined by a spiral band, of no particular ornamental value. Inside the ecliptic, the pointers are joined in an asymmetric pattern.

Table A106-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
2	*Dhanab al-Qayṭus Sha[mālī]* ι Ceti	
3	*Baṭn [al-Ḥūt]*	β Andromedae
4	*Fam al-Qayṭus*	γ Ceti
5	*Ṣadr al-Qayṭus*	π Ceti
6	*Ghūl*	β Persei
7	*Jadhmā'*	α Ceti
8	*Tālī Masāfat al-Nahr*	γ Eridani
9	*ᶜAyn al-Thawr*	α Tauri
10	*ᶜAyyūq*	α Aurigae
11	*Rijl [al-Jawzā' al-Yusrā]*	β Orionis
12	*Yad al-Jawzā' Yusrā*	γ Orionis
13	*Yad al- Jawzā' [al-Yumnā]*	α Orionis
14	*Rijl al-Jawzā' Yumnā*	κ Orionis
15	*Shiᶜrā Yamānī*	α Canis Majoris
16	*Shiᶜrā Shāmī*	α Canis Minoris
17	*Ṭarfat Safīna*	ρ Puppis

	Star Name	Identification
18	*Mankhir al-Shujā^c*	σ Hydrae
19	*Fard al-Shujā^c*	α Hydrae
20	*Qā^cidat al-Bāṭiya*	α Crateris
21	*^cAnāq*	ζ Ursae Majoris
22	*Janāḥ al-Ghurāb*	γ Corvi
23	*Simāk A^czal*	α Virginis
24	*Simāk Rāmiḥ*	α Bootis
25	*Nayyir Fakka*	α Coronae Borealis
26	*^cUnuq al-Ḥayya*	α Serpentis
27	*Rukbat al-Ḥawwā'*	ζ Ophiuchi
28	*Muqaddam*	ρ Ophiuchi
29	*[Rās al-] Jāthī*	α Herculis
30	*Rās al-Ḥawwā'*	α Ophiuchi
31	*Nasr Wāqi^c*	α Lyrae
32	*Minqār al-Dajāja*	β Cygni
33	*Nasr Ṭā'ir*	α Aquilae
34	*Dhanab Dulfīn*	ε Delphini
35	*Dhanab al-Dajāja*	α Cygni
36	*Fam al-Faras*	ε Pegasi
37	*Dhanab al-Jadī*	δ Capricorni
38	*Sāq Sākib al-Mā' Janūbī*	δ Aquarii
39	*Mankib al-Faras*	β Pegasi
40	*Kaff al-Khaḍīb*	β Cassiopeiae^

PLATES

There are four plates calibrated to the following latitudes.

Table A106-2 Plates

	φ	**Longest day**
1a	21°	13;16 hours
1b	23°	13;25 hours
2a	27°	13;42 hours
2b	29°	13;51 hours
3a	32°	14;8 hours
3b	36°	14;27 hours
4a	18°+72°	13;5 hours; ---
4b	0°+90°	

Altitude circles are drawn for every 6° and numbered in the usual style on both sides of the meridian. Azimuth circles are drawn for every 10° above and below the horizon on 1a; only below the horizon on 1b. They are not drawn on other plates.

On all plates, under the eastern horizon is written *al-mashriq* and under the western horizon *al-maghrib.*

Plain lines for seasonal hours are drawn on plates 1 to 3 and numbered from the western horizon in *abjad* symbols. Dotted lines for equal hours are drawn from the western horizon on plates 1 to 3 and these are numbered in common Arabic/Persian numerals from 1 to 12.

On plate 4a, plain lines for seasonal hours are drawn and numbered from the western horizon in *abjad* symbols; dotted lines for equal hours from the western and eastern horizons are drawn and these too are numbered from the western horizon in common Arabic/Persian numerals.

On plate 4b, at latitude 0° the lines for seasonal and equal hours become the same. These are numbered both in *abjad* symbols and common Arabic/Persian numerals, both starting from the western horizon and reaching up to the eastern horizon. Below the

horizon is written on the right *lā ^{c}arḍ lahu,* on the left *sā^{c}āt 12.* This is with reference to the equator. Just above the north point is written *al-^{c}arḍ tis^{c}īn* ('the latitude is ninety[degrees]')

There is no plate bearing the tablet of ecliptic coordinates and tablet of horizons.

GEOGRAPHICAL GAZETTEER

Engraved in two circles with the names, longitudes and latitudes of 38 localities. In the outer circle, the writing is upside-down, i.e. the tops of the letters are towards the centre of the astrolabe; in the inner circle they are the other way round. In the both circles, the outermost unit (in the outer circle, it is the latitude; in the inner circle, it is the place name) is enclosed in an oval cartouche.

Figure A106.4 – Geographical Gazetteer (photo courtesy Professor Owen Gingerich)

Table A106-3 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
1	Makka Muᶜaẓẓam	77;10	21;40
2	Madīnat Rasūl[499]	75;20	25;0
3	Jidda	76;0	21;0
4	Bayt al-Maqdis	66;30	31;50
5	Dimashq	70;0	33;0
6	Ḥalab	72;10	35;50
7	Baghdād	82;0	33;25
8	Tabrīz	82;0	38;0
9	Shīrāz	88;0	29;36
10	Qazwīn	85;0	36;45
11	Iṣfahān	87;40	32;40
12	Mashhad	92;30	36;0
13	Harāt	94;20	34;30
14	Balkh	81;0	36;11
15	Bukhārā	94;30	39;50
16	Samarqand	99;36	39;37
17	Kābul	84;40	34;30
18	Kashmīr	88;0	34;0
19	Tubbat	110;0	40;0
20	Qandahār	87;40	33;0
21	Multān	87;25	39;40

499 In the blank circle above the name is added ᶜAlī[yat] al-Salām.

	Place Name	L	φ
22	Lāhūr	109;20	31;50
23	Tānīsar	112;33	30;10
	Inner Circle		
24	Dihlī	113;28	28;29
25	Akra	115;0	26;43
26	Kawāliyār	114;0	26;29
27	Qannawj	114;50	26;55
28	Banāras	117;20	26;15
29	Aḥmadābād	108;40	23;15
30	Ajmīr	111;5	26;0
31	Aḥmadānakar	105;0	19;0
32	Burhānpūr	103;0	20;30
33	Janīr?	110;0	18;48
34	Bijāpūr	104;20	17;14
35	Kūlkanda	105;19	18;4
36	Dawlatābād	111;0	20;30
37	Ujjayn	110;50	23;30
38	Kanbāyat	109;20	26;20

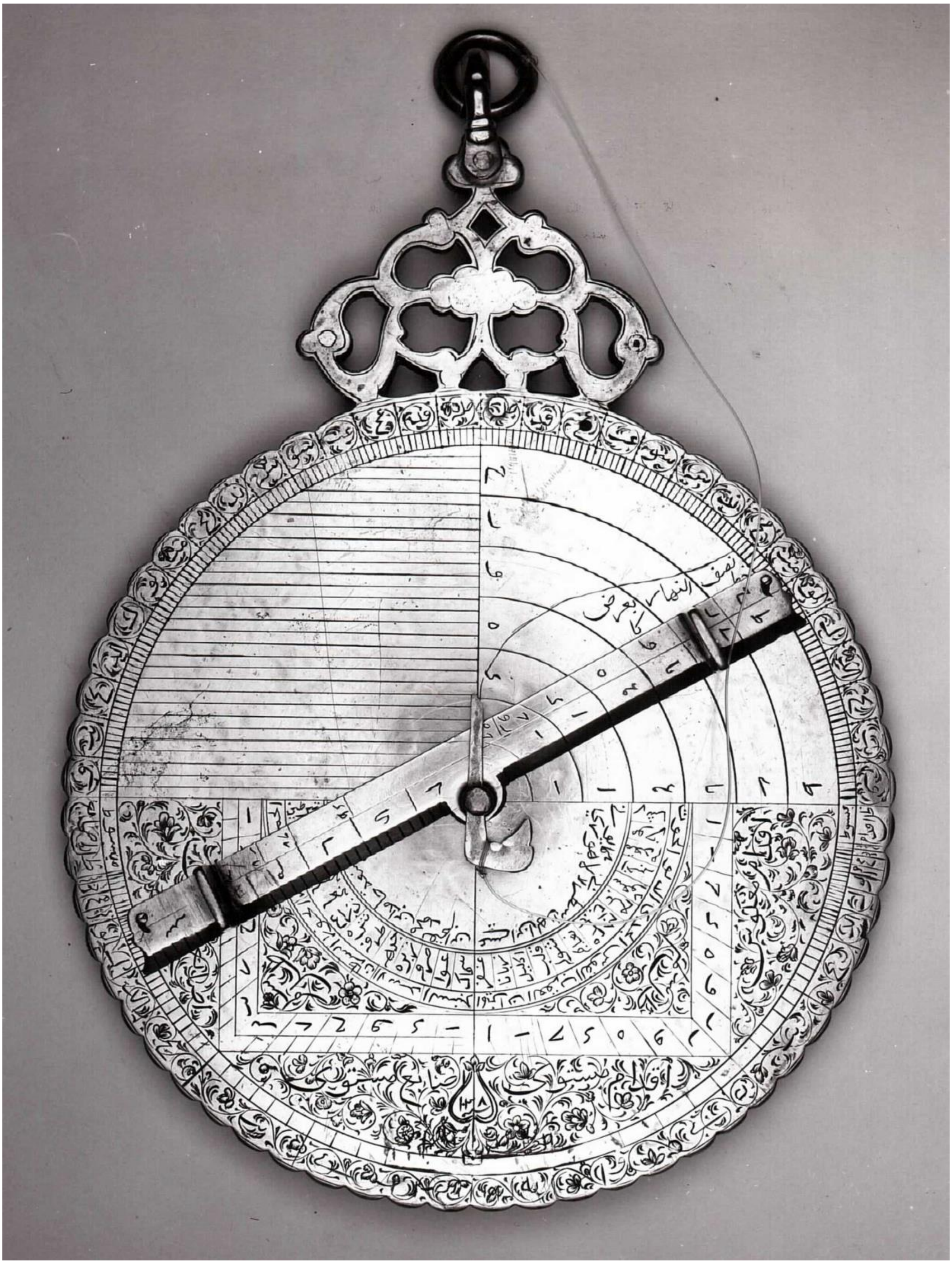

Figure A106.5 – Back of the astrolabe (photo courtesy Professor Owen Gingerich)

BACK

On the back, the rim of the upper two quadrants is divided in 1° and 6° and labelled in 6's inside the cartouches as 6—90; 90—6. There are ornamental lines inside these cartouches; these are more on the back than on the front.

In the upper left quadrant 30 (or 29 more exactly) horizontal parallels are drawn. In the upper right quadrant six declination arcs are drawn and the spaces inside (which represent pairs of signs) are labelled with the serial numbers of the signs along the two radii. On this quadrant is plotted a curve of the midday altitude of the sun at the latitude of 21° (i.e. of Mecca) with the label *khaṭṭ niṣf al-nahār bi-ᶜarḍ 21.*

In the lower half, there are shadow squares, on the left for a base of 12 and on the right for a base of 7. The scales are divided and labelled in the usual manner.

Inside the shadow square are semi-circular scales carrying the names of the 12 zodiac signs and the corresponding 28 lunar mansions.

The rim of the lower half carries the cotangent scales. Here also the numbers are written in oval cartouches which are filled with ornate designs to such an extent that the *abjad* numbers are difficult to read. At the end of the scale on the left is written *ẓill aṣabiᶜ mustawī*; at the end of the scale on the right *ẓill aqdām mustawī.*

The empty spaces between the semi-circular scales and the shadow squares, both inside the shadow squares and outside squares, are filled with floral design with creepers, leaves and flowers.

ALIDADE ETC

The alidade is graduated. On the right into six units and marked from the centre 10, 20, 30, ….60. On the left the divisions correspond to the arcs drawn in the solar quadrant and numbered accordingly with the serial numbers of the zodiac signs.

INSCRIPTION

Inside the two semi-circular scales of lunar mansions and zodiac signs, is engraved upside down the astrolabe maker's signature along its semi-circular outline. Below the shadow squares, in an upside-down heart-shaped cartouche is engraved the year of manufacture *sanah 1038.*

> *aḥqar al-ᶜibād ṣanᶜat ḥāmid ibn muḥammad muqīm ibn ᶜīsā ibn allāhd[ād] asṭurlābī lāhūrī humāyūnī.*
>
> 'The work of the least worthy of servants [of God], Ḥāmid, son of Muḥammad Muqīm, son of ᶜĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn.'

The initial *m* in *muqīm* is not correctly formed (it looks like *ya* without diacritics) and the name Allāhdād misspelt.

PROVENANCE

The Library Register entry:

Purchased from Persian Antique Gallery, 32 East 57th Street, New York 22, New York. Received 10 January 1956. *552-1 Astrolabe, Persian, 17th Century, Brass instrument with dial and rule on a circular base, diameter 12.7 cm, $ 120 00 Hofer f[un]d.

BIBLIOGRAPHY

Owen Gingerich, 'Rara Astronomica,' *Harvard University Bulletin,* 19.2 (April 1971), no. 67, plate V.

A107⊙ ASTROLABE BY ḤĀMID, AH 1069 (AD 1658)

21 Rabī’ l-awwal 1069 (17 December 1658)

Diameter 112 mm

Hyderabad, Salar Jung Museum (#114/2/xxxv)

Figure A107.1 – Front of the astrolabe (photo by S. R. Sarma)

Components

Body with *kursī* (d. 112, h. 141, t. 7), shackle and ring, rete for 28 stars, 5 plates, alidade, pin and horse.

Front

The ring and shackle have diamond-shaped cross sections. The *kursī* is high; it is a slightly tapering rectangle with three lobes on either side at the upper corners. The top culminates into a trefoil to which the shackle is attached. The *kursī* is solid and unadorned.

The rim of the mater is graduated into 1° and 6° and labelled clockwise from 6 to 90 separately in each quadrant.

Figure A107.2 – Rete of the astrolabe (photo by S. R. Sarma)

RETE

The rete is very unusual in its design and unlike any of the retes of the Lahore astrolabes. The peripheral Capricorn ring and eccentric ecliptic ring are held together by the equinoctial and solstitial bars, both completely represented. The equinoctial bar is counter-changed at its two intersections with the ecliptic ring. The solstitial ring is interrupted by large oval frames on either end and a small circle in the middle. The equator is represented in two small segments, one inside the ecliptic ring and the other below it.

On the inner edge of the ecliptic ring, there are small protrusions on which the zodiac signs are labelled numerically from 0 to 11 in *abjad* notation. There are also

protrusions to mark the limits of the signs. Each sign is divided in groups of 6° and labelled. There are 28 star pointers, some of which are set up on triangular arches. The star *al-Wāqi*ᶜ is shown as the head of a bird with large outstretched wings. There is a prominent handle with a crown-like cross section.

Table A107-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus [Shamālī]*	ι Ceti
2	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
3	*Fam al-Qayṭus*	γ Ceti
4	*Ṣadr al-Qayṭus*	π Ceti
5	*Ghūl*	β Persei
6	*Tālī Masāfat al-Nahr*	γ Eridani
7	*Dabarān*	α Tauri
8	*ᶜAyyūq*	α Aurigae
9	*Rijl al-Jawjā’*	β Orionis
10	*Yad al-Jawjā’*	γ Orionis
11	*Yad al-Jawjā’-Yumnā*	α Orionis
12	*Rijl al-Jawjā’-Yumnā*	κ Orionis
13	*Shiᶜrā Yamānī*	α Canis Majoris
14	*Shiᶜrā [Shāmī]*	α Canis Minoris
15	*Minkhir al-Shujāᶜ*	σ Hydrae
16	*Fard al-shujāᶜ*	α Hydrae
17	*Qāᶜidat al-Bāṭiya*	α Crateris
18	*Simāk Aᶜzal*	α Virginis
19	*Simāk Rāmiḥ*	α Bootis

	Star Name	Identification
20	*Nayyir Fakka*	α Coronae Borealis
21	*[c]Unuq al-[Ḥayya]*	α Serpentis
22	*Rās al-Jāthī*	α Herculis
23	*Rās al-Ḥawwā'*	α Ophiuchi
24	*Nasr Wāqi[c]*	α Lyrae
25	*Nasr Ṭā'ir*	α Aquilae
26	*Dhanab al-Dālfīn* (sic!)	ε Delphini
27	*Fam al-Faras*	ε Pegasi
28	*Sāq Sākib al-Mā' J[anūbī]*	δ Aquarii

PLATES

There are five plates with projections for eight different latitudes. On these, the altitude circles are drawn for each 6° and azimuth circles for each 10° below the horizon. There are plain lines for seasonal hours and dotted lines for equal hours from the western horizon. The following latitudes are served by the five plates.

Table A107-2 Plates

	φ	Longest Day
1a	18° + 72°	13;4,36 hours
2a	20°	13;42,56 hours
2b	23°	13;25,4 hours
3a	25°	13;33,36 hours
3b	27°	13;42,46 hours
1b	29°	13;51,36 hours
4a	32°	14;8,0 hours

	φ	Longest Day
4b	36°	14;27,10 hours
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

On plate 1a, there are combined projections for 18° and 72°. But the latter is not labelled.

Figure A107.3 – Geographical Gazetteer (photo by S. R. Sarma)

Geographical Gazetteer

On the inner side of the mater, a gazetteer of 57 localities is engraved in two concentric circles. It is the most carelessly engraved gazetteer in the Lahore astrolabes, both from the point of calligraphy and arrangement. The calligraphy is very poor, and there is no pattern in the arrangement of the localities, Indian and Iranian places are mixed up arbitrarily. Several names and numerical data are indecipherable.

Table A107-3 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
1	Makka Mu[c]azẓam	77;10	21;40
2	Madīnat Mubārak	75;20	24;50
3	Ṭā[c]if	77;30	21;20
4	Hajar Baḥrayn	83;15	25;15
5	Jidda	76;0	21;0
6	Miṣr	63;0	30;20
7	Hajar ?	78;30	28;30
8	Kūfa	79;30	31;30
9	Baghdād	80;15	33;20
10	Shīrāz	88;0	39;30 !
11	Bu[s]ṭ	100;0	33;0
12	Qandahār	107;40	33;0
13	Kābul	104;40	34;30
14	Balkh	101;0	36;41
15	Ṭūs	92;30	36;0
16	Bukhārā	96;30	39;10
17	Samarqand	99;0	40;0

	Place Name	L	φ	
18	Tubbat	110;0	40;0	
19	Kashmīr	105;0	35;0	
20	Lāhūr	109;20	31;50	
21	Dihlī	113;18	28;13	
22	Sulṭānkūt ?	109;0	23;0	
23	Hānsī	112;25	29;45	
24	Tānīsar	112;13	30;10	
25	Kawāliyār	114;0	26;29	
26	Jawnbūr	119;6	26;36	
27	Bānāras	117;20	26;15	
28	Kanbāyat	109;20	22;20	
29	Māhūr	106;0	24;40	(Mathurā ?)
30	Aḥmadnakar	107;40	19;22	
31	Aḥmadābād	108;0	23;0	
32	Sarūnj ?	113;6	24;30	
33	Ujjayn	112;0	22;30	
34	Multān	107;35	29;40	
35	Ajmīr	111;5	26;0	
	Inner Circle			
36	Dawlatābād	101;0	20;30	
37	Janīr ?	110.0	18;48	
38	Bījāpūr	114;20	17;17	
39	Kūlkanda	115;19	18;4	
40	Akra	115;4	26;43	

	Place Name	L	φ
41	Awadh	118;6	27;22
42	Badāwan	114;59	27;32
43	Kūpāmāū	114;33	26;45
44	Kara Mānikpur	118;10	26;49
45	Qannawj	114;50	26;35
46	Lakhnaū	114;53	26;30
47	Kūl Jalālī	114;19	28;4
48	Sawmnāth	106;0	17;0
49	Jamkūt	176;0	5;0
50	Sulṭankūt	115;0	28;30
51	Nahrawara ?	78;20	28;30
52	Samarkand	96;30	39;30
53	Badakhshān	104;25	36;10
54	Khujand	100;35	41;15
55	Tūn	92;30	34;30
56	Nishābūr	92;30	36;21
57	Qazwīn	85;0	36;35

Figure A107.4 – Back of the astrolabe (photo by S. R. Sarma)

BACK

The rim of the upper half carries the scales of altitude, divided in 1° and 6° and labelled as 6—90; 90—6. The rim of the lower half is engraved with the cotangent scales.

The upper left quadrant bears 30 horizontal parallels. The solar quadrant on the right is divided into six segments, each representing a pair of zodiac signs, which are marked by their serial numbers 0 to 11 along the two radii. Here is plotted a curve for the midday altitude of the sun at 20° latitude, presumably for Mecca. In the lower half is engraved a double shadow square, on the left for a base of 7 and on the right for a base of 12 with the usual divisions and labels.

Inside the shadow squares is engraved a table of correspondence between the signs of the zodiac (marked by their serial numbers 0-11) and the lunar mansions (marked by their names in full).

ALIDADE ETC

The alidade is straight and plain without any graduations or any other writing on it. It appears to be original, but a cylindrical sighting tube was attached to it later on. The pin and the wedge also appear to be original. The wedge combines the forms of a serpent and a horse, with a slit for the mouth and a hole for the eye at the back of the head.

INSCRIPTION

The maker's inscription is engraved partly above the semi-circular table of zodiac signs and lunar mansions (in two semicircles) and partly below the shadow squares (in one straight line) and reads thus:

> *ṣanᶜat aqall al-ᶜibād ḥāmid ibn muḥammad muqīm ibn ᶜīsā ibn allāhdād asṭurlābī lāhūrī humāyūnī*
> *fī al-ta'rīkh 21 rab[ī]' l-awwal sanah 1069.*
> 'Made by the least of the servants [of God] Ḥāmid, son of Muḥammad Muqīm, son of ᶜĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, on the date 21 of the month Rab[ī]' l-Awwal of the year 1069 [Hijrī]'

The date corresponds to 17 December 1658.

BIBLIOGRAPHY

Sarma 1996, pp. 20-22, pl. 9.

A108⊙ ASTROLABE BY ḤĀMID, 1071 AH (AD 1661)

9 Jumādā al-Awwal 1071 (9 January 1661)

Diameter 112 mm

Paris, Institut du Monde Arabe (AI 86-27)

CCA 3538; Répertoire 3

Figure A108.1 – Mater with the geographical gazetteer (photo courtesy Institut du Monde Arabe)

COMPONENTS

Only the mater is extant with *kursī* (d. 112, h.148, t. 6) and shackle.

FRONT

The ring is missing. The shackle is trifoliate. The *kursī* is lobed and has a trifoliate finial. The *kursī* is pierced symmetrically, producing at the centre a cartouche with three lobes on each side. The limb, the back plate and the *kursī* are cast separately and joined together with several rivets. The ends of the circular ring meet at the south point at the top centre; the ends have not been joined properly. The limb is divided in 1° and 6° and labelled clockwise in 6s from 6 to 90, separately in each quadrant.

GEOGRAPHICAL GAZETTEER

The gazetteer is engraved in two concentric circles separated by an empty circle. In the outer circle, the tops of the letters are towards the centre; in the inner circle towards the outer periphery. The writing is uneven and clumsy; in some places over-written. Unlike his father Muqīm, Ḥāmid has difficulty in engraving the place names within the space of one cell. In one case (no. 2) the name is continued into the empty circle above; in another case (no. 56) the name occupies two cells. There are 57 place names with their longitudes and latitudes.

Table A108-1 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
1	Makka Muᶜaẓẓam	77;10	21;40
2	Madīnat Rasūl ᶜAlīyat al-Salām	75;20	24;50
3	Jidda	76;0	21;0
4	Ṭāᶜif	77;30	21;20
5	Bahrayn	83;15	25;15
6	Bayt al-Maqdis	66;30	31;50

	Place Name	L	φ
7	Miṣr	63;0	30;20
8	Dimashq	70;20	33;20
9	Kūfa	79;30	31;30
10	Baghdād	80;15	33;20
11	Madā’in	80;20	33;0
12	Iṣfahān	86;40	34;0
13	Shīrāz	88;0	29;30
14	Yazd	89;0	35;20
15	Bust	100;0	33;0
16	Qandahār	107;40	33;0
17	Tabrīz	82;0	36;20
18	Qazwīn	85;0	36;15
19	Tūn	92;30	36;0
20	Badakhshān	104;25	36;10
21	Kābul	104;40	34;30
22	Kashmīr	105;0	35;0
23	Ṭūs	92;30	36;0
24	Balkh	101;0	36;41
25	Bukhārā	96;30	39;10
26	Samarqand	99;0	40;0
27	Tubbat	110;0	40;0
28	Kāshghar	106;30	44;0
29	Multān	107;35	29;40
30	Lāhūr	109;20	31;50

	Place Name	L	φ	
31	Dihlī	113;18	28;13	
32	Akra	115;4	26;43	
33	Ajmīr	111;5	26;0	
34	Aḥmadābād	108;0	23;0	
35	Sarūnj	113;6	24;30	
	Inner Circle			
36	Dawlatābād	111;0	20;30	
37	Aḥmadnakar	illegible	19;22	
38	Janīr ?	110;0	18;48	
39	Pījāpūr	114;20	17;17	
40	Kūlkand	115;9	18;4	
41	Burhānpūr	112;0	21;21	place name barely legible
42	Ujjayn	112;0	22;30	
43	Bānāras	117;20	26;15	
44	Lakhnaw	114;13	26;30	
45	Jawnbūr	119;6	26;36	
46	Qannawj	114;50	36;30 !	
47	Kawāliyār	114;0	26;29	
48	Awadh	118;6	27;22	
49	Badāwan	114;59	27;32	
50	Kūl Jalālī	114;19	28;4	
51	Tānīsar	112;33	30;10	
52	Hānsī	112;25	29;45	
53	Sālkūt	109;0	33;0	

	Place Name	L	φ	
54	Sunnām	112;25	30;30	
55	Kūpāmaū’	116;33	26;15	
56	Kara Mānikpūr	118;10	26;19	written in two cells
57	Kanbāyat	109;20	22;20	

BACK

The rim of the two upper quadrants is divided in 1° and 6° and labelled as 6—90; 90—6. The rim of the lower half carries the cotangent scales; the left half bears uneven cells marked with the numbers 6, 12, 18, 24, 30, 36, 42, 48, 54; 60 followed by the label *ẓill aṣābi*^{c}*;* the right half bears uneven cells marked with the numbers 6, 12, 18, 24, 30, 36, 42, 48, 54; 60 followed by the label *ẓill aqdām.* In the inner circle, each of these cells on the left and right are divided into 6 parts.

The upper left quadrant carries 30 horizontal parallels. In the upper right quadrant are drawn 6 declination arcs. These are labelled with the serial numbers 0 to 11 of the corresponding signs along the vertical and horizontal radii. Above these is drawn a graph of the meridian altitude of the sun for the latitude 20° (roughly for Mecca) with the label *khaṭṭ niṣf al-nahār bi-* ^{c}*arḍ 20.*

In the lower half are engraved the shadow squares, on the left for a gnomon of 12 digits and on the right for a gnomon of 7 digits. The scales are divided and labelled in the usual manner.

Figure A108.2 – Back of the Astrolabe (photo courtesy Institut du Monde Arabe

Inside the shadow squares are two semi-circular scales; the outer one is engraved with the serial numbers of the zodiac signs from 0 to 11; the inner scale carries the names of the corresponding 28 lunar mansions.

INSCRIPTION

In the space between the horizontal diameter of the astrolabe and the semi-circular scales of signs and lunar mansions is engraved the astrolabe maker's signature in four lines thus:

*ṣan*c*ah qalīl al-*c*ibād ḥāmid ibn muḥammad muqīm*
ibn c*isā ibn allāhdād lāhūrī asṭurlābī*
humāyūnī taḥrīr fī al-tārīkh 9
shahr jumādā al-awwal

below the table of shadows is added *sanah 1071.*

> 'Made by the least of the servants [of God], Ḥāmid, son of Muḥammad Muqīm, son of cĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn. Completed (*taḥrīr*) on the date 9 of the month Jumādā I of the year 1071 [Hijrī].

The date translates to 9 January 1661.

PROVENANCE

Formerly in the collection of Georges Prin, Paris, and in the collection of M. Destombes, Paris.

BIBLIOGRAPHY

Moliérac 1989, pp. 105-106.

A109 ASTROLABE BY ḤĀMID, 1071 AH (AD 1660-61)

Diameter 103 mm

Cologne, PC

Répertoire 9

Figure A109.1 – Front of the astrolabe (photo by the owner)

This astrolabe didplays better workmanship as compared to the others with the wall-crafted *kursī* and rete.

COMPONENTS

Mater with *kursī* (d. 103, h. 142), ring and shackle, rete for 34 stars, 4 plates, alidade, pin and wedge. The pin and wedge appear to be replacements.

Figure A109.2 – All the components of the astrolabe (photo by the owner)

FRONT

The *kursī* is reticulated with a symmetrical pattern; the two profiles are formed by ogees at the base and top with a lobe in between; the finial is trifoliate. The shackle is also trifoliate; the ring is plain and large.

The limb is divided in 1°, 3° and 6° and numbered in 6s from 6 to 180 and again from 6 to 180. The single degree divisions are rather uneven.

Figure A109.3 – Rete of the astrolabe (detail of Figure A109.2)

RETE

The slender peripheral Capricorn ring and the broader ecliptic ring are held together by the tracery that joins the various star pointers. The east-west equinoctial bar and the south-north solstitial bar are not represented at all. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names. Each sign is divided into 5 parts on the edge of the ecliptic ring, but not numbered. There is no handle to turn the ecliptic ring; the Capricorn index is not well defined.

There are 34 named star pointers which are joined by a tracery of tendrils. These are not listed here because no good photo of the rete is available.

PLATES

There are four plates, each with a projecting tooth at the south point which would fit into the slot at the corresponding place in the rim of the mater. The first three plates

serve the latitudes from 20° to 36°. On these plates, altitude circles are drawn for every 6° and numbered on both sides of the meridian. Azimuth arcs are drawn only on the plate for 20° for every 10° above and below the horizon. Those for every 30° are dotted.

In the lower half of the plates, there are plain lines for seasonal hours and dotted lines for equal hours drawn from the western horizon. Both sets are jointly numbered from 1 to 12 along the circle of equator.

It is not known which two sides belong to which plate; therefore, the sides are numbered serially from 1 to 8 below.

Table A109-1 Plates

	φ	Longest Day
1	20°	13;42,16 hours!
2	23°	13;25,4 hours
3	27°	13;42,46 hours
4	29°	13;51,36 hours
5	32°	14;8,0 hours
6	36°	14;27,10 hours
7	Tablet of ecliptic coordinates with the label *ṣafīḥat mīzān al-ᶜankabūt*	
8	Tablet of horizons with the label *ṣafīḥa āfāqī*	

Figure A109.4 – Geographical gazetteer (photo by the owner)

GEOGRAPHICAL GAZETTEER

On the inner side of the mater is engraved the geographical gazetteer in two circles with the names, longitudes and latitudes of 34 localities, mostly Indian.

Table A109-2 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
1	Makka Muᶜaẓẓam	76;10	21;40

2	Madīnat Rasūl ᶜAlīyah al-Salām	75;20	24;50
3	Jadda	76;0	21;0
4	Kūfa	79;30	31;30
5	Baghdād	80;15	33;20
6	Iṣfahān	86;40	34;25
7	Shīrāz	88;0	29;15
8	Qandahār	107;40	33;0
9	Multān	107;35	29;40
10	Lāhūr	109;20	31;50
11	Dihlī	113;18	28;13
12	Akbarābād	115;4	26;43
13	Ajmīr	111;5	26;0
14	Aḥmadābād	108;0	23;0
15	Surūnj	113;6	24;10
16	Ujjayn	112;0	22;30
17	Burhānbūr	112;0	21;21
18	Dawlatābād	111;0	20;30
19	Aḥmadnakar	107;40	19;22
20	Junīr	110;0	18;48
21	Bījāpūr	114;20	17;17
22	Kū[l]kanda	115;19	18;4
23	Mahūra	116;0	24;40
	Inner Circle		
24	Bānāras	117;20	26;15
25	Qannawj	114;50	26;35

26	Lakhnaw	114;53	26;30
27	Kawāliyar	114;0	26;29
28	Tānīsar	112;25	30;10
29	Sunnām	112;25	30;30
30	Hānsī	112;25	29;45
31	Sālkūt	109;0	33;0
32	Kābul	104;40	34;30
33	Kashmīr	105;0	35;0
34	Tubbat	110;0	40;0

BACK

The rim of the two upper quadrants is divided in 1°, 3° and 6° and labelled as 6—90; 90—6.

The upper left quadrant carries 30 horizontal parallels. In the upper right quadrant are drawn 6 declination arcs. These are labelled with the serial numbers 0 to 11 of the corresponding signs along the vertical and horizontal radii. Above these is drawn a graph of the meridian altitude of the sun for the latitude 20° (roughly for Mecca) with the label *khaṭṭ niṣf al-nahār bi- ᶜarḍ 20.*

In the lower half are engraved the shadow squares, on the left for a gnomon of 12 digits and on the right for a gnomon of 7 digits. The scales are divided and labelled in the usual manner. A table of triplicities is engraved inside the shadow squares with the heading *jadwal muthallathāt laylī wa nahārī.*

The rim of the lower half carries the cotangent scales; the left half bears unequal cells marked with the numbers 6, 12, 18, 24, 30, 36, 42, 48, 60 followed by the label *ẓill aṣābiᶜ mabsūṭ;* the right half bears unequal cells marked with the numbers 6, 12, 18, 24, 30, 36, 42, 48, 60 followed by the label *ẓill aqdām mabsūṭ*. In the inner circle, each of these cells on the left and right are divided into 6 parts.

Inside these cotangent scales, there are two semi-circular rows carrying the names of the 12 signs of the zodiac and those of the 28 lunar mansions.

Figure A109.5 – Back of the astrolabe (photo by the owner)

ALIDADE

The alidade has ornate ends with two decorative holes on each side and an ornate centre-piece, but it is not graduated.

Figure A109.6 – Maker's signature (detail of Figure A109.4)

INSCRIPTION

The maker's signature is engraved above the semi-circular row carrying the names of the 28 lunar mansions. It reads as follows:

ṣan^{c}at qalīl al-^{c}ibād ḥāmid

ibn muḥammad muqīm ibn ^{c}īsā ibn allāhdād asṭurlābī

lāhūrī humāyūnī

sanah 1071

'Made by the least of the servants [of God], Ḥāmid, son of Muḥammad Muqīm, son of ^{c}Īsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn. Year 1071[Hijrī].'

PROVENANCE

Damms Antikvariat, Oslo, Catalogue no. 100, 1968, Lot 254, with photo on the frontpage.

A110 ASTROLABE BY ḤĀMID, 1086 AH (AD 1676) [500]

6 Dhū-l-qaʿda 1086 (22 January 1676)

Diameter 141 mm

PLU, ex-London, Sotheby's

CCA 3822; Répertoire 4

Figure A110.1 – Front of the astrolabe (© Sotheby's, London)

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500 Entry based on the description in Sotheby's, Cataloguing Preview, *Arts of the Islamic World* (L05221), London 10/12/2005. The photos are kindly provided by Sotheby's.

COMPONENTS

Body with *kursī* (d. 141), shackle and ring, rete for 39 stars, 5 plates, alidade, pin and horse. The limb and the *kursī* are cast as one piece and riveted to the back plate.

FRONT

The shackle is trifoliate to which a flattish ring is attached. To this is attached a second ring (a bent wire the two ends of which are not joined), which is probably a modern one. The *kursī* is worked *à jour* with a small cartouche in the middle. Whether the *kursī* has a trifoliate finial or not cannot be seen from the photos. The limb divided in 1°, 2° and 6° and labelled in 6's from 6 to 90, separately for each quadrant.

Figure A110.2 – Rete of the astrolabe (© Sotheby's)

RETE

The peripheral Capricorn ring is unusually wide; the ecliptic ring is slightly narrower. The two rings are held together by the equinoctial and solstitial bars; the former has a counter change at its intersection with the ecliptic ring on the left.

The ecliptic ring is divided into the 12 zodiac signs and labelled with their names. Each sign is divided into units of 6° and numbered accordingly. The tracery supporting the star pointers resembles the same in A105. The Capricorn index is arch-shaped.

Table A110-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
2	*Dhanab al-Qayṭus J[anubī]*	β Ceti
3	*Janb al-Musalsala*	β Andromedae (= *Baṭn al-Ḥūt*)
4	*Ghūl*	β Persei
5	*Ṣadr al-Qayṭus*	π Ceti
6	*Tālī Masāfat al-Nahar*	γ Eridani
7	*Dabarān*	α Tauri
8	*ᶜAyyūq*	α Aurigae
9	*Rijl al-Jawzā' Yusrā*	β Orionis
10	*Yad al-Jawzā' Yusra*	γ Orionis
11	*Yad al-Jawjā'*	α Orionis
12	*Rijl al-Jawzā'*	κ Orionis
13	*ᶜAbūr*[501]	α Canis Majoris

501 Here and in the next row, Ḥāmid employs other names for *Shiᶜrā Yamānī* and *Shiᶜrā Shāmī,* as his father Muqīm does in his astrolabe A025. On these two new terms, see Kunitzsch 1959, pp. 73-74.

	Star Name	Identification
14	*Ghumayṣā'*	α Canis Minoris
15	*Minkhir al-Shujā*ᶜ	σ Hydrae
16	*Fard al-Shujā*ᶜ	α Hydrae
17	*Qalb al-Asad*	α Leonis
18	*Ẓahr Dubb Akbar*	α Ursae Majoris
19	*Qā ᶜidat al-Bāṭiya*	α Crateris
20	*Janāḥ al-Ghurāb*	γ Corvi
21	*Simāk A*ᶜ*zal*	α Virginis
22	*Simāk Rāmiḥ*	α Bootis
23	ᶜ*Anāq*	ζ Ursae Majoris
24	*Fakka*	α Coronae Borealis
25	ᶜ*Unuq al-Ḥayya*	α Serpentis
26	*Rās al-Jāthī*	α Herculis
27	*Qalb al-*ᶜ*Aqrab*	α Scorpii
28	ᶜ*Ayn al-Tinnīn*	γ Draco
29	*Rās al-Ḥawwā*	α Ophiuchi
30	*Waqi*ᶜ	α Lyrae
31	*Muqaddim*	δ Ophiuchi
32	*Minqār al-Dajāja*	β Cygni
33	*Ṭā'ir*	α Aquilae
34	*Dhanab al-Jadī*	δ Capricorni
35	*Dulfīn*	ε Delphini
36	*Fam al-faras*	ε Pegasi
37	*Sāq Sākib al-Mā'*	δ Aquarii

	Star Name	Identification
38	*Kaff al-Khaḍīb*	β Cassiopeiae
39	*Surrat al-Faras*	δ Pegasi

PLATES

There are five plates with the following specifications:

Table A110-2 Plates

	φ	Longest Day
1a	20°	13;20 hours
1b	29;36°	13;56 hours
2a	32;25°	14;12 hours
2b	38;40°	14;48 hours
3a	40;50°	14;58 hours
3b	18°+72°	13;7 and 21;0 hours
4a	36°	14;32 hours
4b	38°	14;40 hours
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

It is strange that there are no plates for the three Mughal imperial cities Agra (27°), Delhi (29°) and Lahore (32°). On plates 1 to 4, altitude circles are drawn for each 6° and azimuth arcs for each 15° below the horizon. There are lines for seasonal hours and equal hours. Only two of the five plates have a peg at the bottom to fit into the hole at the exact place in the limb of the mater. It is not clear why the other three are not provided with such a peg.

Geographical Gazetteer

On the inner side of the mater is engraved a gazetteer with the longitudes and latitudes of 42 localities in two concentric circles. The data is arranged in curved segments; the curves in the two circles tilt in opposite directions; this is one of the few ornate features which Ḥāmid borrowed from his father. However, the letters are incised here with a blunt burin and therefore are not sharp. The contrast between the letters here and on the limb is striking. The localities in the inner circle are from the Indian subcontinent, otherwise there is no logic in their sequence.

Figure A110.3 – Geographical gazetteer (© Sotheby's)

Table A110-3 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle[502]		
1	Makka … Musharraf	77;10	21;40
2	Madinat Ṭayyiba	75;20	25;00
3	Tā’if	77;10	21;20
4	Bayt al-Maqdis	63;30	31-30
5	Miṣr	63;20	30;20
6	Baṣra	84;0	30;0
7	Kūfa	79;30	31;30
8	Baghdād	82;0	38;15
9	Iṣfahān	87;17	32;25
10	Shīrāz	88;0	29;39
11	Mashhad Maqdis	92;30	36;0
12	Yazd	89;0	32;0
13	Tabrīz	82;0	38;0
14	Nakhjawān	81;15	38;40
15	Shamākhī	84;30	40;50
16	Qazwīn	85;0	36;0
17	Qandahār	107;40	33;0
18	Samarqand	99;36	36;39
19	Balkh	101;0	36
20	Bukhārā	92;30	29;50

502 Sotheby’s catalogue reads the names in the outer circle from right to left, but those in the inner circle from left to right. Here the names are read from right to left in both cases.

	Place Name	L	φ
21	Kābul	104;0	35;0
22	Kashmīr	105;0	35;0
23	Kirmān	91;30	30;0
	Inner Circle		
24	Tanīsar	112;30	30;0
25	Siyalkut	109;0	33;0
26	Kawāliyār	112;0	26
27	Ujjayn	110;50	23;30
28	Jawnpūr	119;6	26;36
29	Qannawj	114;50	26;20
30	Ajmīr	115;5	26;0
31	Banāras	117;20	26;15
32	Akra	115;4?	26;43 ?
33	Dihlī	113;18	28;13
34	Lahāwar	109;20	31;30
35	Multān	107;25	29;50
36	Aḥmadābād	108;40	23;0
37	Bandar Sūrat	110;0	22
38	Burhānpūr	112;0	21;21
39	Kūlkanda	115;19	18;4
40	Bījāpūr	114;40	17;17
41	Aḥmadnakar	115;0	19;0
42	Dawlatābād	111;0	20;0

BACK

The rim of the two upper quadrants carries the altitude scales, which are divided in 1°, 2° and 6° and labelled as 6—90; 90—6. In the upper left is the trigonometric quadrant with 60 horizontal and 60 vertical parallels, with each fifth dotted. Semi-circles are drawn with the vertical and horizontal radii as diameters.

On the upper right is the solar quadrant, with 15 declination arcs drawn at non-uniform intervals. The names of the signs and the values of the decans (10, 20, 30) are engraved along the vertical and horizontal radii. Three graphs (not sigmoid as in other Lahore astrolabes) are drawn for the latitudes 20°, 36° and 38°, accompanied by labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 20, khaṭṭ niṣf al-nahār bi-ᶜarḍ 36* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ 38.* Close to the centre is engraved the signature of the maker in three lines (for which see below).

In the lower half, there are shadow squares, on the left for a base of 6 (12) digits and on the right for a base of 7 feet. The four scales are accompanied by the following labels:

Vertical scale on the left:	*ẓill sullam aṣābiᶜ maᶜkūs*
Horizontal scale on the left:	*ẓill sullam aṣābiᶜ mustawī*
Horizontal scale on the right:	*ẓill sullam aqdām mustawī*
Vertical scale on the right:	*ẓill sullam aqdām maᶜkūs.*

Inside the shadow squares is inscribed the table of 'excess of revolution' (*al-jadwal faḍl al-dawr*).

The lower rim bears the cotangent scales and their subdivisions. The scale on the left is labelled as *ẓill aṣābiᶜ mabsūt* and the scale on the right as *ẓill aqdām mabsūt.*

Figure A110.4 – Back of the astrolabe, alidade, pin and horse (© Sotheby's)

Between the lower rim and the shadow squares is engraved a scale. On this David King writes as follows in the Sotheby's catalogue preview:

> Around this is a most unusual scale labelled *jadwal al-mayl*, 'table of solar declination', in which the solar declination is given to degrees, minutes and seconds for each 6° of the elongation of the sun from the equinoxes. Entries are given for the pairs of zodiacal signs from Aries and Libra to Virgo and Pisces, the outer ones labelled (unusually) *sh-h* for *shamaliyyah*, 'northern' and the inner ones *j-h* for *janubiyyah*, 'southern', with variations *sh-sad-h* and *j-sad-h* where the declination is increasing, the letter *sad* standing for the word *sa'id*, 'increasing'. Corresponding entries on either side of the table should be identical since the function is symmetrical about the equinoxes and the solstices, but this is not the case. The maximum value at the solstices is 23°30'0''. The inclusion of this table in this form does not reflect well on the technical knowledge of the maker. The values were doubtless extracted from some more extensive table and merit further investigation.

ALIDADE

The alidade bears a sexagesimal scale for use with the trigonometric quadrant in the upper register on the right hand side. On the lower register are markings for a universal sundial when the sighting plate on this side is used as a gnomon. The left hand side of the alidade carries a solar scale with the zodiac signs marked by their serial numbers.

Figure A110.5 – Astrolabe maker's signature (detail of Figure A110.4)

INSCRIPTION

The maker's signature is engraved in three lines at the apex of the upper right quadrant and reads thus:

ṣan^c^at aḍ^c^af al-^c^ibād ḥāmid ibn muḥammad muqīm ibn

^c^īsā ibn allāhdād asṭurlābī humāyūnī. Taḥrīrā fī al-tārīkh

6 fī shahr dhu al-qa^c^ida sanah 1086.

'The work of the least of the slaves [of God], Ḥāmid, son Muḥammad Muqīm, son of ^c^Īsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn. Accomplished on the date 6 in the month of Dhu' l-Qa'd[a] in the year 1086 [of the Hijra].'

The date translates to 21 January 1676.

PROVENANCE

Sold Christie's, 10 November 1964, lot 4b

Sold Sotheby's, 19 December 1966, lot 73

Collection Nicolas Landau, Paris

Sold Hôtel Drouot Rive Gauche, Paris, 28 April 1977.

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Sotheby's, London, auction catalogue of 19 December 1966, lot 73.

C. Boisgirard & A. de Heeckeren, *Instruments Scientifiques Anciens,* auction catalogue of 28 April 1977, Paris, no. 671, where the year is wrongly mentioned as '1084 de l'hégire, 1673/74 de l'ère chrétienne'.

A111 ASTROLABE BY ḤĀMID, 1087 AH (AD 1677)[503]

4 Dhu'l Ḥijja 1087 (6 Feb 1677)

Diameter 140 mm

Kolkata, Asiatic Society

Répertoire 5

This astrolabe was with the Asiatic Society, Kolkata, in 1890. Whether it is still there or not could not be ascertained in spite of repeated letters to the Asiatic Society.

COMPONENTS

Mater with *kursī* (d. 140), rete, probably 5 plates; alidade, pin and wedge are missing. The *kursī* is worked *à jour.* On it is engraved the name Muḥammad Sa[c]īd, presumably the owner.

GEOGRAPHICAL GAZETTEER

In two circles; outer circle: Mecca, Medinah, Ṭā[c]if, Jidda, … Lahāwar, Dehlī, Agra, Benares: inner circle: Aḥmadnagar … Sonārgām Bangālah, Pānīpath.

INSCRIPTION

> *[c]amal aqall al-[c]ibād ḥāmid ibn muḥammad muqīm ibn [c]īsā ibn allāhdād asṭurlābī lāhūrī taḥrīr fī al-tārīkh 4 shahar ẓi-l ḥjjah sanah 1087.*
> 'The work of the lowest of the servants [of God], Ḥāmid, son of Muḥammad Muqím, son of [c]Īsa, son of Allāhdād, the astrolabist of Lahore, completed on the 4th day of the month Zi-l-Ḥijjah, in the year 1087 (= 1677 A.D.).

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503 This entry is based on a brief description given by Hoernle at that meeting of the Asiatic Society, Calcutta, ca. 1890, when this and another astrolabe were exhibited; these two astrolabes were purchased by Maheśchandra Nyáyaratna at Allahabad for Rs. 9 for the Society; cf. Hoernle 1890.

A112$^{\odot}$ ASTROLABE AND QIBLA INDICATOR BY ḤĀMID, 1098 AH (AD 1686)

21 Muharram 1098 (7 December 1686)

Diameter 300 mm

London, Nasser D. Khalili Collection of Islamic Art (# SCI 5)

Figure A112.1 – The top of the lid (left) and the inner side of the main plate with slots for compass mountings (right) (photos by S. R. Sarma)

Figure A112.2 – Trifoliate shackle (photo by S. R. Sarma)

This is a massive and complex instrument which combines the features of the astrolabe and *qibla* indicator. It is constructed as a circular casket with a lid which can be screwed to the main plate that constitutes the mater. The reverse side of this main plate is designed as in other astrolabes, but the obverse side is different. Here there is no limb with a degree scale. Instead, an uneven lip which is added all around and a high boss is affixed at the centre. The plates and the rete rest on this lip and on the boss without touching the inner surface of the mater. On this surface are soldered a pair of projecting slots on either side of the boss. These slots may have contained the mounting for a compass, but it is now missing. The seven plates have large holes a little above the centre through which the compass may have become visible for use. Since there is no degree scale on the mater, it is now engraved on all latitude plates. The geographical gazetteer which is normally engraved on the inner surface of the main plate is here engraved on the inner side of the lid.

The gazetteer contains many Indian names for the first time. There are also many new place names of on the plates. Moreover, on the back there are some new astrological tables. I could not, regretfully, decipher all the engravings because of the limited time I had and because of the very small script.

COMPONENTS

Body with *kursī* (d. 300, h. 350, t. 40), shackle and ring, rete (d. 284) for 32 stars, 7 plates (d. 284) and lid. Alidade, pin and horse are missing.

FRONT

The ring and shackle are massive; the latter has a perfectly trifoliate form. The solid *kursī* is rather small for this large instrument. Its profiles are lobed; there is no trifoliate finial. A crude decoration is engraved on the back; on the front an inscription, probably the name of an owner, is erased.

Figure A112.3 – Front of the astrolabe (photo by S. R. Sarma)

RETE

The rete is framed by a narrow ring leaving a recess between it and the ring of Capricorn, so that the degree scale on the rim of the latitude plates becomes visible through this recess. The Capricorn ring and ecliptic ring are held together by the

complete equinoctial bar and the solstitial bar which is represented in parts. The equinoctial bar and the ecliptic ring have counter changes at their points of their intersection. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names. Each sign is further subdivided into 5 parts of 6° each and numbered accordingly. The Capricorn index is large and shaped like an arch. There is no handle to rotate the rete. The 32 named star-pointers are joined by a floral tracery.

Figure A112.4 – Rete of the astrolabe (photo by S. R. Sarma)

Table A112-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus*	β Ceti

	Star Name	Identification
2	*Fam al-Qayṭus*	γ Ceti
3	*Ṣadr al-Qayṭus*	π Ceti
4	*Tālī Masāfat al-Nahr*	γ Eridani
5	*ᶜAyyūq*	α Aurigae
6	*Rijl al-Jawzā' Yusrā*	β Orionis
7	*Yad al-Jawzā' [Yusrā]*	γ Orionis
8	*Rijl al-Jawzā' [Yumnā]*	κ Orionis
9	*Shiᶜrā Yamānī*	α Canis Minoris
10	*Shiᶜrā Shāmī*	α Canis Majoris
11	*Minkhar al-Shujāᶜ*	σ Hydrae
12	*Fard al-Shujāᶜ*	α Hydrae
13	*Qā'idat al-Bāṭiyah*	α Crateris
14	*Janāḥ al-Ghurāb*	γ Corvi
15	*Simāk Aᶜzal*	α Lyrae
16	*Simāk Rāmiḥ*	α Bootis
17	*Nayyir al-Fakka*	α Corona Borealis
18	*ᶜUnuq al-Ḥayya*	α Serpentis
19	*Qalb al-ᶜAqrab*	α Scorpii
20	*Rās al-Jāthī*	α Herculis
21	*Rās al-Ḥawwā'*	α Ophiuchi
22	*Yad al-Ḥawwā'al-Muqaddam*	δ Ophiuchi
23	*Nasr Wāqiᶜ*	α Lyrae
24	*Nasr Ṭā'ir*	α Aquilae
25	*Dhanab al-Dulfīn*	ε Delphini

	Star Name	Identification
26	*Fam al-Faras*	ε Pegasi
27	*Dhanab al-Jadī*	δ Capricorni
28	*Sāq Sākib al-Mā'[Janūbī]*	δ Aquarii
29	*Janāḥ al-Faras*	γ Pegasi
30	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
31	*Surrat al-Faras*	δ Pegasi
32	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are seven plates; they all have a large hole above the centre through which the compass projects outside and become visible. Plates 1 to 5a serve different latitudes while 5b is engraved with multiple horizons. The rims on both sides of these 5 plates carry degree scales which are divided in 0;20°, 1°, 6° and numbered clockwise from 1 to 90, separately on each quadrant. Moreover, on these scales the four cardinal points are named: *janūb* (south), *maghrib* (west), *shamāl* (north), *mashriq* (east).

On these plates altitude circles are drawn for each 1° and numbered on both sides of the meridian. Azimuth arcs are drawn below the horizon for each 6°.

The Khalili catalogue says that the plates are engraved below the horizon with lines for Babylonian hours, but there are no hour lines on these plates. Instead there are two sets of lines for *ghaṭīs*; one of equal *ghaṭīs* drawn from the western horizon and numbered from 1 to 32; the other of unequal *ghaṭīs* drawn from both the horizons up to the meridian and numbered 1—15; 15—1.

Near the east point is written *mashriq* and near the west point *maghrib.* The specification of the plate, viz., the latitude and the maximum duration of daylight are engraved below the eastern and western ends of the oblique horizon. On the east given the maximum number of hours (*sā*ᶜ*āt*) and on the west the latitude (*al-*ᶜ*arḍ*) and the maximum number of *ghaṭīs* (spelt *karī-hā*). It is surprising that in this astrolabe, where

all other details are meticulously engraved, the same amount of care is not shown in mentioning the duration of the longest days in exact numbers of hours and minutes and exact numbers of *ghaṭīs* and *palas.* What are engraved are gross approximations.

Finally, in these astrolabe plates, the space inside the circle of Cancer is kept free of altitude circles, azimuth arcs and hour lines. In this space are drawn lines radiating from the centre, indicating the azimuths of *qibla* of certain places with their names. Unfortunately, the names are too close together and several are filled with patina; therefore, they cannot be easily deciphered.

Table A112-2 Plates

S.No.	φ	Longest Day in Hours	in *ghaṭīs*
1a	17°	---	---
1b	18°	13;20	32!
2a	20°	13;18!	32!
2b	21°	13;18!	32!
3b	23°	13!	33!
3a	25°	13!	33!
4a	27°	13;43	34!
4b	29°	13;52	34!
5a	32°	14;8	35
5b	Tablet of horizons		
6a	*Qibla* directions from various localities		
6b	*Qibla* directions from various localities		
7a	*Qibla* directions from various localities		
7b	*Qibla* directions from various localities		

Figure A112.5 – Plate 5a for Lahore at latitude 32° (photo by S. R. Sarma)

Plate 5 is cut out of a thicker sheet and is heavier than the others. On the obverse side, it carries the projections for Lahore at latitude 32°. In the middle of the plate are the lines of azimuth of *qibla* of as many as 17 places: Qulzūm az Kanār Daryā; Madinat al-Ḥikmā, Baᶜalbak, Ḥalab, (?), Qazwīn, Astarābād, Ṭūs, Siyālkūt, (?). Sunām, Hindūn, Banāras, Dabūl, Barūdah and Nahrawar.

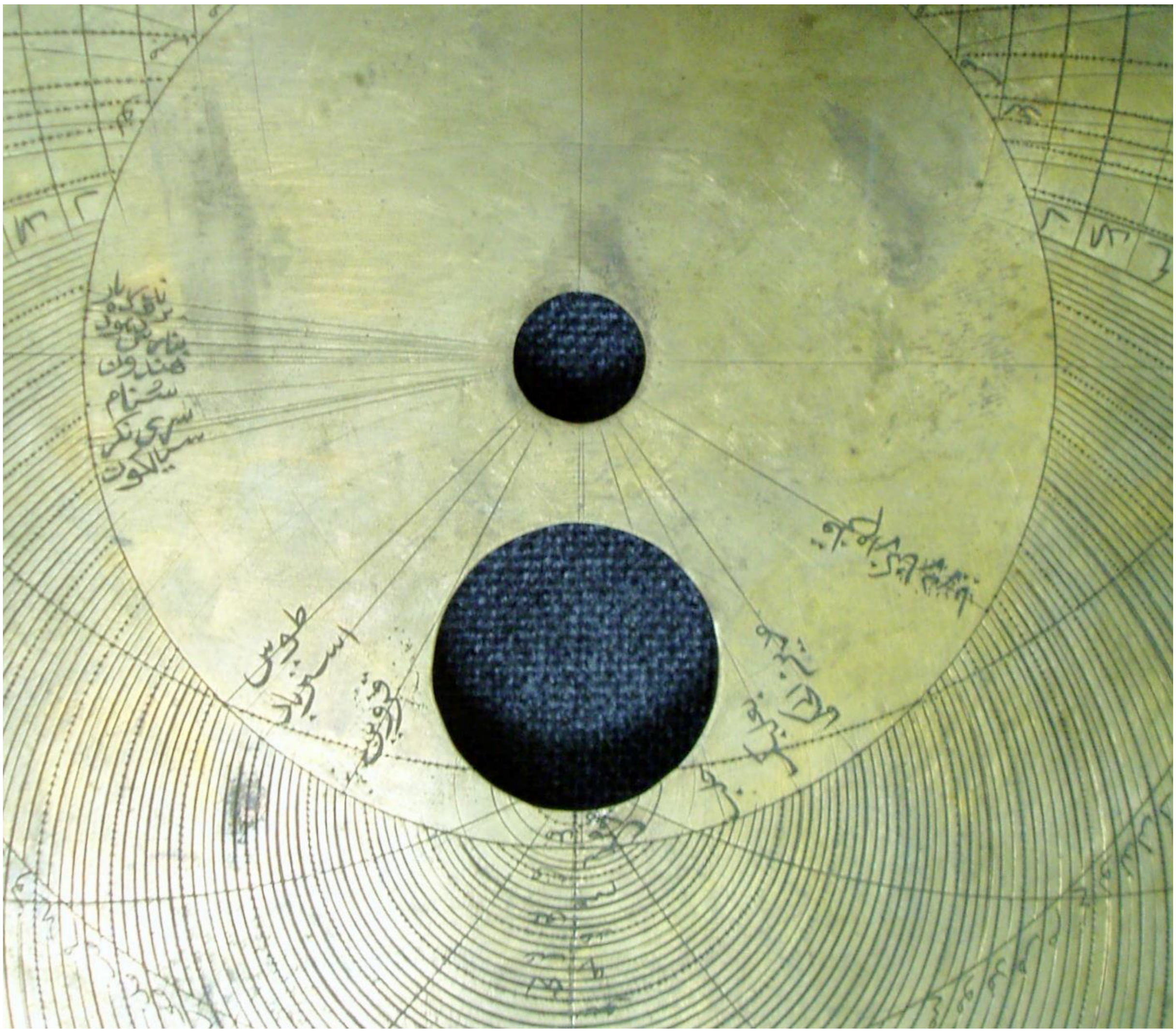

Figure A112.6 – Detail of Figure A112.5, placed here upside down, i.e. north upwards, to facilitate the reading of the place names.

Plate 5b is engraved with the tablet of horizons with the label *ṣafīha āfāqī.* It carries half horizons for every degree from 4° to 66°, arranged in 4 sets with intervals of 4°. There are declination scales along the diameters between the equator and the tropics; these are divided in 1° and 6° and marked 6, 12, 18, 23;30. Those outside the equator carry the label *al-maghrib* (west) and those inside *al-sharq* (east). One of the latter is written, by mistake, *al-gharb.* Here also the space inside the circle of Cancer is kept free; here are also drawn lines of the azimuth of *qibla* of 7 localities, one of them being Jawnpur.

There is no plate devoted to the tablet of ecliptic coordinates.

Plates 6ab and 7ab carry lines radiating from the centre to indicate the azimuth of *qibla* from various localities.[504] Like the other plates, these too are engraved with the equator and the tropics and with the vertical and horizontal diameters. The cardinal points are labelled *janūb* (south), *maghrib* (west), *shamāl* (north) and *sharq* (east). Along the circle of Capricorn are written the names of the localities and lines connecting these with the centre are drawn. Inside the circle of equator, the azimuth of *qibla* is engraved. For example, 11 *darja* 28 *daqīqa* (11 degrees, 28 minutes).

Figure A112.7 – Detail of plate 6b (photo by S. R. Sarma)

On plate 6a, 30 localities are inscribed in this manner; these include Kalkanda, Burhānpūr, Mandū, Kanbāyat, Ahmadābād, Jawnpūr, Kawāliyār, Amroha, Peshāwar, Qandahār, Badakhshān, Khutan, Kāshghar, Shīrāz, Sabzwar, Iṣfahān, Baṣra, Kāshān, Qumm. Bulghār, Wāsit, Kūfa, Ardbill, ᶜAdan.

Plate 6b carries the data of 24 localities which include Sarandīp, Bījāpūr, Aḥmadnagar, Bandar Sūrat, Narwar, Akbarābād, Dihlī, Tattah, Sarhind, Siyālkūt,

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504 King 1999b, p. 156: 'On a small number of Lahore instruments, however, gazetteers with qibla values do occur … on one of these (#4223), made by Ḥāmid ibn Muḥammad Muqīm Lāhūrī in 1098 H (=1686), the qiblas are represented graphically on some of the plates by a series of radial lines from the centre.'

Kashmīr, Ghaznī, Kirmān, Iṣṭakhr, Nīshābūr, Astarābād, Rayy, Tāliqān, Baghdād, Madīnat Ṭayyiba and Bayt al-Maqdis.

On plate 7a are engraved 20 localities such as Rahtās, Awrankābād, Ujjayn, Bahrūj, Banāras, Hindūn, Badā'ūn, Hansī Ḥiṣṣār, Kābul, Balkh, Samarqand, Bukhārā, Tūn, Jarjān, Hamadān, Mawṣil and Baᶜalbak.

Plate 7b also carries 20 localities which include Dhāka, Rājmahal, Patna, Qannawz, Multān, Lāhūr, Jalālābād, Tubbat, Harat, Ṭūs, Qazwīn, Ḥalab, Dimashq and Iskandariya.

Geographical Gazetteer

The geographical gazetteer is engraved on the inner side of the lid. It provides the names, longitude, latitude, the *inḥiraf* or the azimuth of qibla, and *jihat* for 142 localities, arranged in two circles. Since both circles carry the same number of entries, the writing in the inner circle is much smaller and more difficult to decipher. The locality Tūn is listed twice, under 29 and also under 137, with the same coordinates. Rājmahal (112) and Gaur (113) in Bengal are mentioned here for the first time.

Figure A112.8 – Geographical Gazetteer (photo by S. R. Sarma)

Table A112-3 Geographical Gazetteer

	Place Name	L	φ	*al-qibla samt*	*jihat*
	Outer Circle				
1	Madīnat Rasūl …	75;20	25;20	13;34	SE
2	Bayt al-Maqdis	66;30	32;15	45;18	SE
3	Qayrawan	41;0	21;40	8;9	SE
4	Jarmī Dar al-Mulk Habasha	65;0	9;30	90;28	NE

	Place Name	L	φ	*al-qibla samt*	*jihat*
5	ᶜAdan	76;0	11;0	104;10	NE
6	Ṣanᶜā‘ Dar al-Mulk Yaman	97;0	14;30	48;48	NE
7	Miṣr	43;20	30;20	31;46	SE
8	Iskandariyya	61;54	25;30	30;39	SE
9	Qulzum az Kanār Daryā	64;0	25;30	30;39	SE
10	Sāwa	85;0	35;0	60;38	SW
11	Qazwīn	45;0	36;0	62;22	SW
12	Iṣfahān	86;40	32;25	49;40	SW
13	Kāshān	86;0	34;0	55;29	SW
14	Qumm	85;40	34;45	48;1	SW
15	Rayy	86;20	35;0	56;32	SW
16	Ṭāliqān	85;45	36;10	60;23	SW
17	Astarābād	89;35	36;50	11;17	SW
18	Janjān	90;0	36;50	50;10	SW
19	Dāmghān	88;55	36;20	50;7	SW
20	Shīrwān	91;30	36;5	45;21	SW
21	Pishāwar	92;30	36;20	43;30	SW
22	Ḥalab	72;10	35;50	71;30	SE
23	Madīnat al-Hikmā	65;40	32;20	55;11	SE
24	Mawṣul	77;0	34;30	89;19	SE
25	Dimashq	70;0	33;15	59;33	SE
26	Baᶜlbak	70;45	38;15	62;16	SE

	Place Name	L	φ	*al-qibla samt*	*jihat*
27	Anṭakiya	71;22	35;30	68;35	SE
28	Laḥā	43;30	24;0	21;40	?
29	Ṭūs	92;30	37;0	45;51	SW
30	Tūn	92;30	34;30	49;49	SW
31	Harat	94;20	34;30	36;51	SW
32	Balkh	101;0	36;41	39;27	SW
33	Badakhshān	104;24	37;0	25;21	SW
34	Kirmān	61;40	35;0	22;30	SW
35	?	77;20	34;0	89;22	SW
36	Bulgār	90;0	29;30!	65;18	SW
37	Kūfa	79;30	31;30	77;31	SW
38	Baghdād	80;0	33;25	77;15	SW
39	Wāsiṭ	81;30	32;20	69;11	SW
40	Baṣra	84;0	30;0	52;8	SW
41	Kāzrūn	87;0	29;15	38;21	SW
42	Shīrāz	88;0	29;6	36;15	SW
43	Iṣṭakhr	88;30	30;0	36;27	SW
44	Jūnahkar (Junagadh)	106;20	22;20	2;30	NW
45	Khanbāyat	107;55	22;20	4;30	NW
46	Barūdah (Baroda)	108;35	22;20	4;55	NW
47	Bharūj	108;25	21;40	5;6	NW
48	Sūrat Bandar	108;10	21;25	0;97	NW

	Place Name	L	φ	*al-qibla samt*	*jihat*
49	Yatar (?) Kujarāt	107;25	28;35	1;45	NW
50	Nadarwār ?	109;40	21;0	7;29	NW
51	?	109;40	20;40	7;43	NW
52	Burhānpūr	102;20	21;21	8;28	NW
53	Awrankābād Dawlatābād[505]	111;0	19;47	10;50	NW
54	Aḥmadnakar	109;25	18;40	11;10	NW
55	?	110;13	18;33	11;?	NW
56	Kalkanda	112;19	18;35	11;15	NW
57	Bījāpūr	113;26	17;17	14;56	NW
58	Mandū	111;36	22;10	5;6	NW
59	Ujjayn	11230	22;15	5;47	NW
60	Sarūj	114;12	24;48	8;18	NW
61	Narwar	114;55	25;30	?;11	NW
62	Rahtas	118;0	35;0	29;36	NW
63	?	100.55	24;12	2;19	NW
64	Lakhnawtī	116;15	27;30	0;0	SW
65	?	118;20	33;5	14;37	SW
66	?	118;35	32;30	13;17	SW
67	Siyālkūt	108;55	32;25	12;58	SW
68	?	108;0	31;40	12;28	SW
69	Lāhūr	109;20	31;50	11;28	SW

505 Two localities in one entry.

	Place Name	L	φ	*al-qibla samt*	*jihat*
70	Lūdhyānā	110;40	31;10	9;32	SW
71	Sirhind	111;30	30;30	30;56	SW
	Inner Circle				
72	Hamadān	83;0	35;10	66;43	SW
73	Bukhārā	97;39	39;36	40;3	SW
74	Samarqand	99;36	39;31	?;?	SW
75	Kāshghar	106;36	44;?	33;2	SW
76	Khutan	103;42	?;?	29;50	SW
77	Hurmūz	92;0	25;0	10;18	SW
78	Qandahār	107;40	33;?	20;10	SW
79	?	82;30	25;10	3;13	SW
80	?	83;30	25;9	1;12	SW
81	Sūstān ?	104;25	26;40	5;34	SW
82	?	105;0	27;40	…	SW
83	Sarī Bakū	112;52	33;10	10;19	SW
84	Kānkara	111;35	33;35	14;3	SW
85	Kīrān	113;20	29;40	4;45	SW
86	Akbarābād	115;0	26;43	00	…
87	Kūl Jalālī	114;50	27;12	00	…
88	Sunām	111;30	29;30	6;10	SW
89	Thānīsar	112;30	30;10	6;36	SW
90	?	112;0	30;0	6;12	SW
91	Hardwar	113;0	30;15	6;20	SW
92	Haḍrat Dihlī	113;35	28;39	3;35	SW

	Place Name	L	φ	*al-qibla samt*	*jihat*
93	Hānsī Hiṣār	112;?	29;45	6;9	SW
94	Mīwāt …	112;25	27;45	?;11	SW
95	?	114;45	28;40	3;0	SW
96	Badāūn	114;55	27;30	0;57	SW
97	Sanbhal	114;40	18;30	?;19	SW
98	Hindūn	114;20	26;35	0;51	SW
99	Ajmīr	111;5	26;50	0;35	SW
100	Dhūl Dahūl	110;20	28;0	4;14	SW
101	Aḥmadābād Kujrāt	108;20	23;0	3;37	SW
102	Kawāliyar	114;56	25;16	0;03	SW
103	Kālpī	116;0	26;35	0;15	SW
104	Qannawj	116;15	36;55!	0;55	SW
105	Bahraij	116;30	28;0	0;35	…
106	Alhābād	116;6	26;?	0;05	NW?
107	Banāras	114;20	27;0	37;35	NW
108	Jawnpūr	117;6	26;30	1;48	NW
109	Rahtās …	118;15	26;30	1;48	NW
110	?	119;2	26;40	1;45	NW
111	Munkīr	120;0	26;6	1;6	NW
112	Rājmahal	121;5	25;15	4;10	NW
113	Kawr (Gaur) Bankāla	121;12	25;0	4;30	NW
114	?	120;0	18;0	12;27	NW
115	Dhāka	126;12	24;0	7;8	NW

	Place Name	L	φ	*al-qibla samt*	*jihat*
116	Baradwān	122;0	28;35	7;22	NW
117	Multān	107;35	29;40	9;6	SW
118	… Makrān	99;0	28;0	12;59	SW
119	Ghaznī	104;5	34;20	21;7	SW
120	Kābul	105;0	34;30	20;27	SW
121	Jalālābād	105;40	34;10	18;30	SW
122	Pashāwar	106;40	33;50	12;30	SW
123	?	107;0	33;24	16;12	SW
124	?	105;15	33;18	12;49	SW
125	Kashmīr	108;0	35;0	29;36	SW
126	Tubbat	110;0	40;0	23;30	SW
127	Basṭām	89;30	35;10	50;2	SW
128	Tabrīz[506]	82;0	38;0		
129	Nakhjawāb	81;15	38;40		
130	Shamākhī	84;30	40;50		
131	Bāb Abwāb	85;0	43;0		
132	Hawsam Kīlān	85;10	37;0		
133	Sarakhs	94;30	37;0		
134	Marw	97;0	37;0		
135	Qā’īn	93;20	33;40		
136	?	95;30	37;0		

506 From here onwards, the *qibla samt* and the *jihat* are not given.

	Place Name	L	φ	*al-qibla samt*	*jihat*
137	Tūn	92;30	34;30		
138	?	85;37	36;31		
139	?	87;20	35;40		
140	Pānīpat	113;9	28;37		
141	Sarāndīb	130;0	10;0		
142	Jadda	76;0	21;0		

BACK

On the back, the rim of the upper half carries altitude scales which are divided in 0.20°, 1°, 6° and numbered in 6s as 6---90; 90---6°. In the upper left quadrant, 60 horizontal and 60 vertical parallel lines; semi-circles are drawn on both the radii. In the solar quadrant on the right, 30 declination arcs are projected stereographically so that the intervals between the lines become gradually smaller as they approach the centre. Such unequal intervals are rare in Lahore astrolabes, but common in Safavid astrolabes. Four curves of the midday altitude of the sun are drawn for latitudes 20°, 21°, 27° and 32°. The first one is accompanied by the full label *khaṭṭ niṣf al-nahār bi-ʿarḍ 20*; at the other curves, only the latitude is given.

In the lower part of the quadrant, below the last of the declination arcs, is an inscription *Mālik Qādirdād Khān Mūhandis 1186 hijrī* (owner: Qādirdād Khān, Engineer/ Architect, 1186 Hijrī = AD 1772-73).

Figure A112.9 – Back of the astrolabe (photo by S. R. Sarma)

In the lower half are the shadow squares, on the left for a gnomon of 12 digits and on the right for a gnomon of 7 feet with the usual labels.

The lower half of the rim carries scales of cotangents and their subdivisions. Below these scales, is a semi-circular row. The right half contains the name of the maker

(which is given below) and the left half the names of the astrological scales inscribed below.

Below this row are 14 semi-circular rows containing an elaborate set of astrological tables such as the correspondence between the 28 lunar mansions and 12 zodiac signs, duodenaries, novenaries, triplicities, limits, faces and so on. This is perhaps the most elaborate collection of astrological tables to be found on any Lahore astrolabe.

Figure A112.10 – Signature of the astrolabe maker (photo S. R. Sarma)

INSCRIPTION

ᶜamal aqall al-ᶜibād ḥāmid ibn muḥammad muqīm ibn ᶜīsā ibn allāhdād asṭurlābī lāhūrī humāynī taḥrīr fī al-tārīkh 21 shahar muharram al-harām sanah 1098.

'The work of the lowest of the servants [of God], Ḥāmid, son of Muḥammad Muqīm, son of ᶜĪsa, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, completed on the date 21 of the holy month Muharram in the year 1098.'

The date translates to 7 December 1686.

BIBLIOGRAPHY

Maddison & Savage-Smith 1997, I, pp. 228-230, item 131 with photos of the front of the astrolabe and of the gazetteer.

A113$^{\odot}$ ASTROLABE BY ḤĀMID, 1099 AH (AD 1688)

12 Rabī^{c} al-Awwal 1099 (17 January 1688)

Diameter 89 mm

London, Guildhall, the Hon'ble Clockmaker's Company Museum

CCA 1115; Répertoire 6

Figure A113.1 – Front of the astrolabe (photo by S. R. Sarma)

COMPONENTS

Body with *kursī* (d. 89, h. 108, t. 6), shackle and ring, rete (d. 69) for about 20 stars, 3 plates, alidade, pin and horse.

FRONT

High solid *kursī* with a trifoliate finial to which are attached a trifoliate shackle and a large ring. On the front and back lines are drawn parallel to the edge of the *kursī.* On the front, inside the line drawn parallel to the edge, the space is excavated and here is written in large letters in relief *Allāhu Akbar.* The empty space around the letters is filled with black colour.

The limb is divided in 1° and 6° and labelled clockwise from 6 to 90, separately for each quadrant.

RETE

The two rings of the Capricorn and ecliptic are held together by an almost complete equinoctial bar (with counter changes at its intersection with the ecliptic ring on the left and at the centre) and by an almost complete solstitial bar. The two are not straight bars, but rather mixed with the tracery that joins the various star pointers.

The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names. Each sign is divided into groups of 6° and numbered accordingly from 6 to 30.

The solstitial bar projects out of the ecliptic ring at the top and touches the degree scale; this is the Capricorn index (*al-mūrī*). There is a handle at the west point on the Capricorn ring for rotating the rete.

There are about 20 star pointers, which are joined by an indifferent tracery.

PLATES

There are only 3 plates extant, although there is space for one or two which are lost.

Table A113-1 Plates

S.No.	φ	Longest Day
1a	21°	13;18 hours
1b	24°	13;53 hours !

S.No.	φ	Longest Day
2a	27°	13;43 hours
2b	29°	13;52 hours !
3a	32°	14;8 hours
3b	36°	14;22 hours !

Altitude circles are drawn for every 6°, azimuths for every 30° above the horizon and for every 15° below the horizon. There are lines for seasonal and equal hours.

GEOGRAPHICAL GAZETTEER

On the inner side of the mater is engraved a geographical gazetteer with the longitudes, latitudes, *inḥiraf* and *jihat* of 23 localities, engraved counter-clockwise from Mecca to Banaras. On the surface can be seen two holes on the meridian at equal distances on either side of the centre which are plugged or filled. But these are not visible on the back. These marks can be seen on the three plates also.

Figure A113.2 – Geographical Gazetteer (photo by S. R. Sarma)

Table A113-2 Geographical Gazetteer

	Place Name	L	φ	*inḥirāf*	*jihat*
1	Makka Mu^c^ẓẓam	77;10	21;40	74 !	SE !
2	Madīnat Ṭayyiba	74;20	25;0	63;34	SE
3	Bayt al-Maqdis	66;30	32;15	45;18	SE
4	Qayrawān	41;0	21;40	10;9	SE
5	Miṣr	63;30	30;20	8;9	SE

	Place Name	L	φ	*inḥirāf*	*jihat*
6	Iṣfahān	86;40	32;25	49;40	SW
7	Kāshān	86;0	34;0	14;19	SW
8	Qum	84;40	34;45	18;1	SW
9	Mashhad Maqdis	92;30	36;0	44;51	SW
10	Balkh	101;0	36;41	29;17	SW
11	Kābul	105;0	34;30	20;27	SW
12	Awrankābād	111;5	19;47	10;27	NW
13	Aḥmadnakar	109;25	18;40	11;10	NW
14	Qal^cahbadar (Gulburga?)	110;13	18;38	11;27	NW
15	Kalkanda	115;19	18;35	11;4	NW
16	Bījāpūr	113;26	17;17	14;56	NW
17	Burhānpūr	112;20	21;21	8;28	NW
18	Lāhūr	109;20	31;50	11;28	SW
19	Dihlī	113;1	28;30	3;35	SW
20	Ajmīr	111;5	25;50	11;25	SW
21	Bandar Sūrat	108;10	21;25	5;17	NW
22	Aḥmadābād	108;20	23;0	3;37	NW
23	Banāras	117;20	27;0	1;35	NW

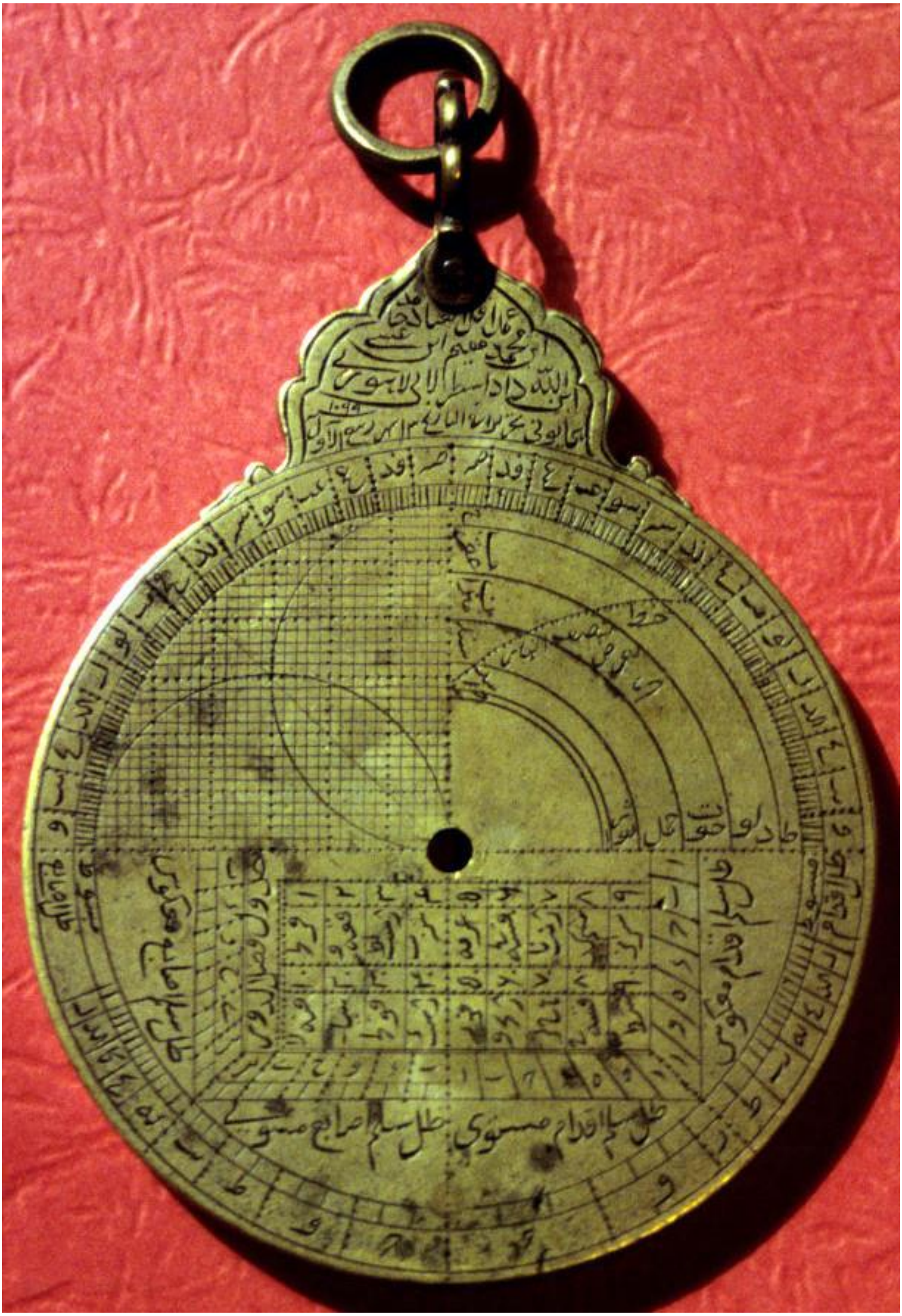

Figure A113.3 – Back of the astrolabe (photo by S. R. Sarma)

Back

The rim of the upper half carries the altitude scales, divided in 1° and labelled in 6's as 6—90;90—6. In the upper left is a trigonometric quadrant with 30 horizontal and 30 vertical parallels, with every fifth line highlighted with dots. Semicircles are drawn on both the radii and a radial line is drawn to 45° on the arc. In the upper right is a solar quadrant with declination arcs drawn at non-uniform intervals. The related pairs of signs are marked along the two radii by their serial numbers. There is a dotted curve showing the solar altitude at midday for latitude 20° with the label *khaṭṭ niṣf al-nahār bi-ᶜarḍ* 20.

In the lower half are drawn shadow squares, on the left for a base of 6 (12) dgits and on the right for a base of 7 feet. The four scales are accompanied by the following labels:

Vertical scale on the left:	*ẓill sullam aṣābiᶜ maᶜkūs*
Horizontal scale on the left:	*ẓill sullam aṣābiᶜ mustawī*
Horizontal scale on the right:	*ẓill sullam aqdām mustawī*
Vertical scale on the right:	*ẓill sullam aqdām maᶜkūs*

The lower rim bears the corresponding cotangent scales and their subdivisions. The scale on the left is labelled as *ẓill aṣābiᶜ mabsūt* and the scale on the right as *ẓill aqdām mabsūt.* Inside the shadow squares is inscribed the table of the 'excess of revolution' (*jadwal faḍl al-dawr*). There are no other astrological tables.

Inscription

On the back of the *kursī* is the astrolabe maker's signature:

ᶜamal aqall al-ᶜibād ḥāmid
ibn muḥammad muqīm ibn ᶜīsā
[ibn] allāhdād asṭurlābī lāhūrī
humāyūnī taḥrīrā fī al-tārīkh 13 shahr rabīᶜ al-awwal sanah 1099

'Made by the least of the slaves [of God] Ḥāmid, son of Muḥammad Muqīm, son of ᶜĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, completed on the date 24 in the month Rabīᶜ I of the year 1099.'

The date corresponds to 17 January 1688.

Provenance

Ex- coll. Nethropp.

A114 ASTROLABE BY ḤĀMID, 1102 AH (AD 1691)

24 Jumādā al-Awwal 1102 (22 Feb 1691)[507]

Diameter 116 mm

PLU, ex-Paris, Brieux

CCA 3517; Répertoire 7

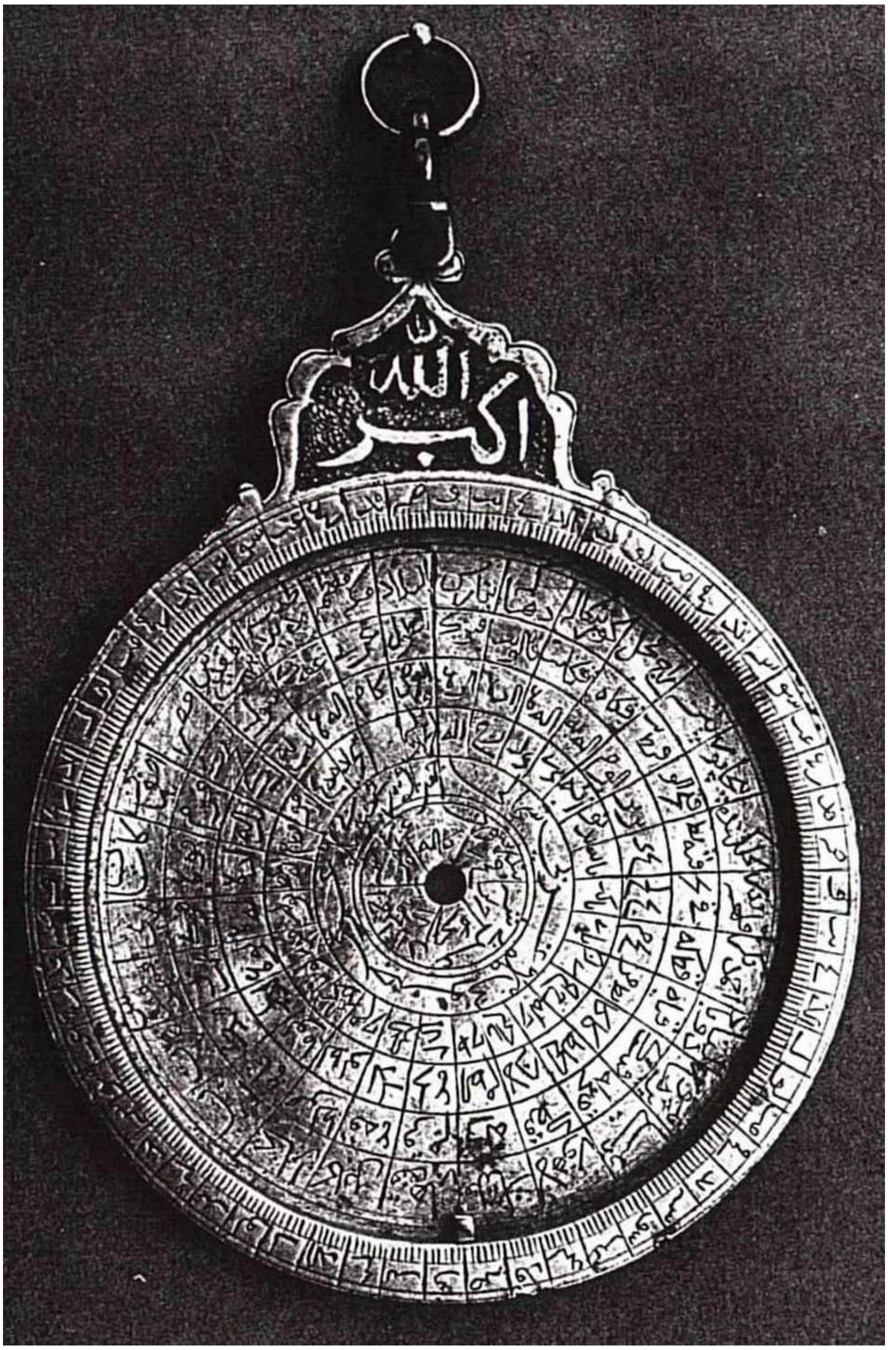

Figure A114.1 – Mater with the geographical gazetteer (photo courtesy Professor David King)

507 The entry is based on the photographs and notes kindly provided by Professor David King.

COMPONENTS

Only the mater (d. 116, t. 8) is extant.

FRONT

High solid *kursī* with a trifoliate finial to which are attached a trifoliate shackle and a large ring. On the front and back decorative lines are drawn parallel to the edge of the *kursī*. On the front, inside the line drawn parallel to the edge, the space is excavated and filled with *Allāhu Akbar* in large letters in relief.

The limb is divided in 1° and 6° and labelled clockwise from 6 to 90, separately for each quadrant.

GEOGRAPHICAL GAZETTEER

On the inner side of the mater is engraved a geographical gazetteer with the longitudes, latitudes, *qiblah samt* and *jihat* of 27 localities, engraved counter-clockwise from Mecca to Banaras. Because of the poor quality of the photograph, several items could not be deciphered.

Table A114-1 Geographical Gazetteer

	Place Name	**L**	**φ**	***qiblah samt***	***jihat***
1	Makka Mu^c^aẓẓam	77;10	21;40		
2	Madīnat Ṭayyiba	75;20	25;0	63;34	SE[508]
3	Bayt al-Maqdis	66;30	32;15	45;18	SE
4	Miṣr	63;20	30;20	31;46	SE
5	Iṣfahān	86;40	32;25	49;40	SW[509]
6	Kāshān	86;0	34;0	15;19	SW
7	Rayy	86;20	35;0	36;37	SW

[508] Nos. 2-4 have *sharqī janūbī,* ES.

[509] Nos. 5-16 have *gharbī janūbī,* SW. Although all these localities have higher latitudes than that of Mecca and thus are to the north, some of these are to the west and some to the east of Mecca. So common designation SW to all these is clearly inappropriate.

	Place Name	L	φ	*qiblah samt*	*jihat*
8	Mashhad Maqdis	92;30	36;0	?	SW
9	Harat ?	104: 20?	?	?	SW
10	?	111;0	36;9		SW
11	Bukhārā	97;39	39;36	40;3	SW
12	Kābul	105;0	34;30	20;27	SW
13	Qandahār	107;40	33;0	20;10	SW
14	Multān	107;35	29;40	9;3	SW
15	Lāhūr	109;20	31;50	11;28	SW
16	Dihlī	113;35	28;39	3;35	SW
17	Burhānpūr	112;20	21;21	8;28	NW[510]
18	Dawlatābād	111;5	19;47	10;50	NW
19	Aḥmadnakar	109;25	18;40	11;10	NW
20	Qalᶜahbadar (Gulburga?)	110;13	18;38	11;27	NW
21	Kalkanda	115;19	18;4	11;14	NW
22	Bījāpūr	113;26	17;17	14;56	NW
23	Patnah	119;12	26;40	1;15	NW
24	Rājmahal	121;5	25;15	4;10	NW
25	Kawr (Gaur) Bankāla	121;12	25;0	4;30	NW
26	Dhāka	127;12	24;0	7;8	NW
27	Banāras	117;20	27;0	1;35	NW

[510] Nos. 7-27 have *gharbī shamālī,* north-west. All these localities are in India and therefore Mecca is to the west in all cases. But some, like nos. 23-27, have higher latitudes; here Mecca would be to the SW and NW.

	Place Name	L	φ	*qiblah samt*	*jihat*
28	Bandar Sūrat[511]	108;30	21;25	?	
29	ᶜAdan	?	?	?	
30	Ajmīr	?	?	?	
31	?	?	?	?	

511 This and the next three places are inscribed inside the inner circle. The last place name and the coordinates are illegible.

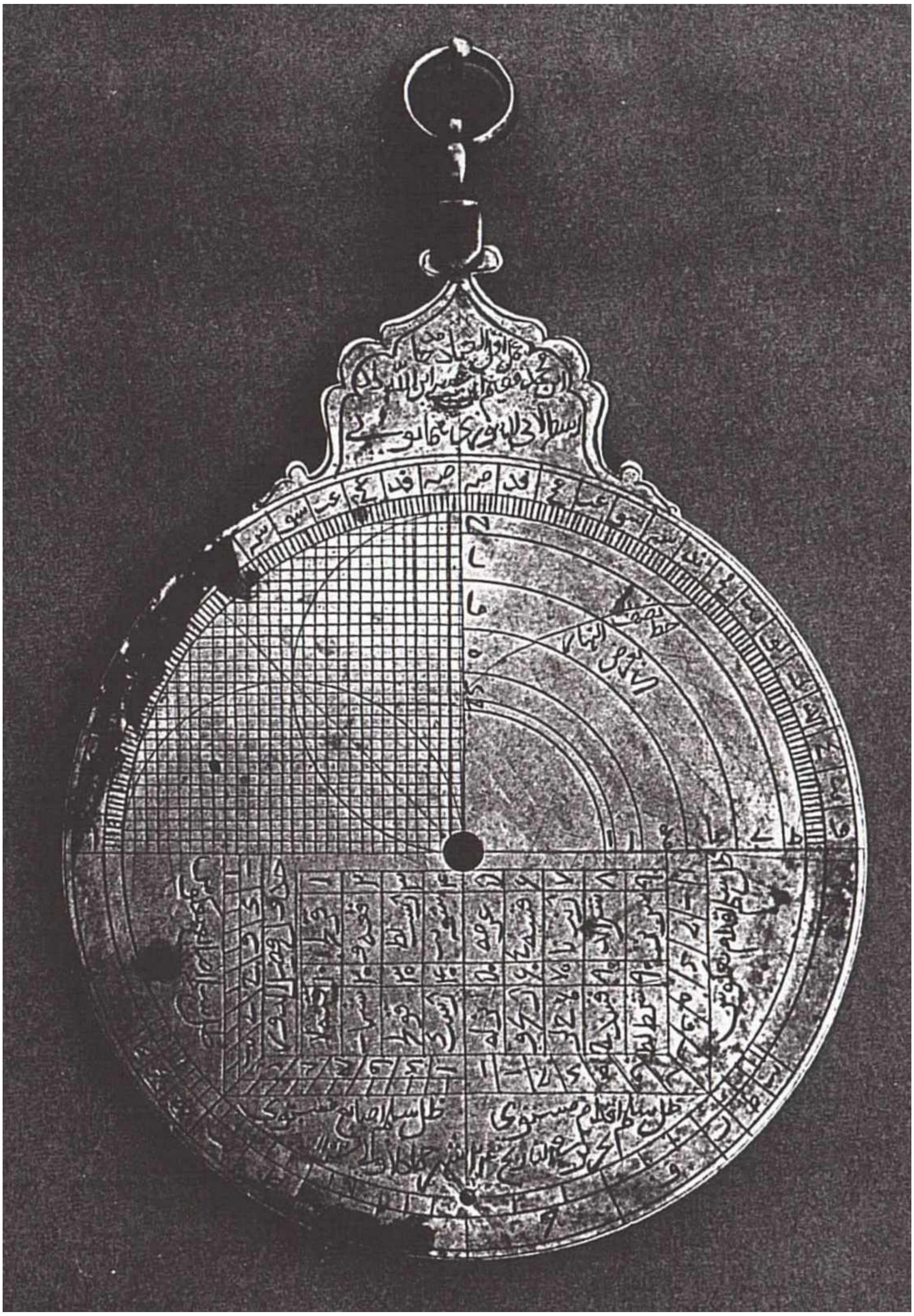

Figure A114.2 – Back of the astrolabe (photo courtesy Professor David King)

BACK

The upper rim carries the altitude scales, which are divided into 1° and 6° and labelled as 6—90; 90—6. The lower rim bears the cotangent scales, but without any labels. In the upper left quadrant are drawn 30 vertical and 30 horizontal parallels with arcs of sine and versed sine and a radial line to 45° which bisects the quadrant. In the

upper right is a solar quadrant with declination arcs at non-uniform intervals, with the serial numbers of the related zodiac signs marked along the two radii. There is a curve showing the solar altitude at midday at latitude 20 with the label *khaṭṭ niṣf al-nahār bi-ᶜarḍ 20.*

In the lower half are drawn two shadow squares, on the left for a base 6 (12) and on the right for a bsse of 7, with the usual labels. Inside the shadow squares is engraved the table of 'excess of revolution' (*faḍl al-dawr*).'

INSCRIPTION

The maker's signature is engraved on the back of the *kursī*; the date is added below the shadow squares:

ᶜamal aqall al-ᶜibād ḥāmid
ibn muḥammad muqīm ibn ᶜīsā ibn allāhdād
asṭurlābī lāhūrī humāyūnī
taḥrīr fī al-tārīkh 24 shahar jumādā al-awwal sanah 1102.

'Made by the least of the slaves [of God] Ḥāmid, son of Muḥammad Muqīm, son of ᶜĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn,
Completed on the date 24 in the month Jumādā I of the year 1102.'

The date corresponds to 22 February 1691.

PROVENANCE

Formerly with Mme. Dominique Brieux until 1992.

A115 ASTROLABE BY ḤĀMID, 1102 AH (AD 1691)

24 Ramadan 1102 (20 June 1691)[512]

Diameter 126 mm

London, PC? ; ex-Milan

Répertoire 8

Figure A115.1 – Front of the astrolabe (photo courtesy Professor Gerard L'E. Turner)

512 The entry is based on Linton 1980, no. 168, pp. 100-101, and on the colour photos of the front and back, and the black-and-white photos of all the plates kindly provided by the late Professor Gerard L'E. Turner when the astrolabe was in Milan.

COMPONENTS

Body with *kursī* (d. 126), shackle and ring, rete for 36 stars, 6 plates; alidade, pin and horse are missing.

FRONT

The *kursī* is high and solid; it terminates in a trefoil-shaped finial to which the shackle and a very large ring are attached. The shackle also, when seen from the side, has a trefoil shape. On the front side of the *kursī* is engraved, in rather large letters, *Allāhu Akbar.* On the reverse is engraved a poem which is followed by Ḥāmid's signature; the latter is continued below the shadow squares.

The limb is divided into 1° and 6° and labelled in 6s from 6° to 90°, separately for each quadrant.

RETE

The two rings of the Capricorn and ecliptic are held together by the complete equinoctial bar and an almost complete solstitial bar. The former has counter changes at its intersection with the ecliptic circle on the left and at the centre. While the equinoctial bar is partly covered by the star pointers and the tracery that joins them, the solstitial bar is completely covered by these. The ecliptic circle is divided into the 12 signs of the zodiac and labelled with their names. On the edge of ecliptic ring there are unnumbered marks, dividing each sign into groups of 6°.

There are 36 named star pointers, which are shaped like the flared petals of tulip flowers, as in the retes by Ḥāmid's father Muqīm. These are joined by a floral pattern. There is a handle at the west point on the Capricorn circle. A pin projecting out of the ecliptic circle and touching the degree scale is the Capricorn index (*al-mūrī*).

PLATES

There are 6 plates of which 5 are calibrated for latitudes ranging from 18° to 40°. These plates are engraved with equal altitude lines for each 6°, azimuth arcs for each 15° below the horizon, and plain lines for seasonal hours and dotted lines for equal hours drawn from both the western and eastern horizons .

Table A115-1 Plates

	φ	Longest Day
1a	18°	13;3 hours
1b	20°	13;20 hours
2a	25°	13;36 hours
2b	27°	13;47 hours
3a	29°	13;52 hours
3b	32°	14; 8 hours
4a	34°	14;12 hours
4b	36°	14;22 hours
5a	38°	14;40 hours
5b	40°	14;48 hours
6a	Tablet of ecliptic coordinates	
6b	Tablet of horizons	

GEOGRAPHICAL GAZETTEER

On the inner side of the mater, a geographical gazetteer is said to have been engraved with the longitude, latitude, *inḥirāf* and *jihat* for 36 localities. It could not by reproduced here as no photo was available.

BACK

The rim of the upper half carries the altitude scales, divided in 1° and 6° and labelled as 6—90; 90—6. The rim of the lower half bears the scales of cotangents. The upper left quadrant contains 30 vertical and 30 horizontal parallels with every fifth line highlighted with dots. There are arcs of sine and versed sine and a radial line to 45° which bisects the two arcs.

In the upper right quadrant there are 6 unevenly spaced arcs of the signs of the zodiac; the signs are numbered along the two radii. There is also a graph of the meridian altitude of the sun for latitude 20° with the label *khaṭṭ niṣf al-nahār bi-ᶜarḍ 20*.

Figure A115.2 – Back of the astrolabe (photo courtesy Professor Gerard L'E. Turner)

In the lower half there are shadow squares, on the left for a base of 12 and on the right for a base of 7 with the usual labels. Inside the shadow squares is engraved a table of 'excess of revolution' (*faḍl al-dawr*).

ALIDADE ETC

The alidade, horse and pin are missing. In the available photos, the components are held together by a pin with a peculiar handle which must a replacement.

INSCRIPTION

On the back of the *kursī* is engraved first a poem:

natash dahān waqad tawāyī ḥakīm naqaṭ mūhūm wakhṭ mustaqīm

'The trace of thy mouth and of thy height, Oh wise man! The imaginary point and the straight line.'

This is followed by Ḥāmid's signature which is continued below the shadows:

ᶜamal aqall al-ᶜibād ibn muḥammad muqīm ḥāmid
bi tārīkh 24 ramaḍān al-mubārak sanah 1102.

'The work of the least of men, the son of Muḥammad Muqīm, Ḥāmid. On the date of the 24th Ramaḍān in the blessed year 1102 [Hijrī].'

The date translates to 21 June 1691. Here Ḥāmid mentions only his father by name and not the other ancestors.

PROVENANCE

Formerly in the collection Jean Tetreau, Paris; of Ferrari, Paris; and of Leonard Linton, Point Lookout. Linton's collection including this astrolabe was auctioned in 1980. This astrolabe was acquired by a private collector in Milan. Around 2010, the Milan collection is said to have been was acquired by Ahuan Art Gallery, London.

BIBLIOGRAPHY

Linton 1980, no. 68, pp. 100-101.

A116 ASTROLABE ATTRIBUTABLE TO ḤĀMID

Not dated

Diameter 132 mm

Hyderabad, Salar Jung Museum (#112/1/xxxv)

Figure A116.1 – Front of the astrolabe (photo by S. R. Sarma)

This and the next astrolabe are remarkably alike in many respects: in the design of the rete, in having a plate where one side is calibrated for multiple horizons and the other side with projections for the latitude of 72° and in having the table of 'the excess of revolution' within the shadow squares. Moreover, in both astrolabes α Canis Majoris is named *ᶜAbūr* as is done in A110 by Ḥāmid. The *kursīs* in both have the same outline, but in the present astrolabe the surface in the front is embellished with a floral design. In both the geographical gazetteer is engraved in two circles and the argument is given only at the beginning of the first circle and not at beginning of the second circle. At the same time, these two have many features in common with the astrolabes signed by Ḥāmid such as the outlines of the *kursī* and the design of the rete. Therefore, these two unsigned astrolabes can be attributed to Ḥāmid.

COMPONENTS

Body with *kursī* (d. 132, t. 6.5) with shackle and ring, rete for 30 stars, 3 plates. Original alidade, pin and wedge are missing. These are replaced by a crude alidade with a sighting tube, a bolt and nut. There are two washers; the larger one has a crown-like projection, probably original.

FRONT

The ring is plain and shackle trifoliate. The *kursī* is solid and shaped like the *kursīs* in several of the astrolabes by Ḥāmid (A105, A111, A112, A113 and A115). On the surface in the front is a pattern engraved in low relief, showing three tulip-like flowers. The limb is graduated in 1° and 6° and numbered clockwise in 6s, from 6 to 180 from the south point up to the north point, and again from 6 to 180 from the north point up to the south point. This is a very unusual method and does not occur anywhere else.

RETE

The rete closely resembles the retes in many of the astrolabes by Ḥāmid in the manner the equinoctial and solstitial bars are shaped and in the tracery that joins the star pointers is designed. The ecliptic ring is divided into 12 signs of the zodiac and labelled with their names. Each sign is further divided in groups of 6° and numbered accordingly as 6, 12, 18, 24, 30. These units are halved to 3° on the edge of the ecliptic ring. The Capricorn index is shaped like thin rectangular stub. A handle was attached near the west point on the peripheral ring. Its top is broken and there remains now only a stub.

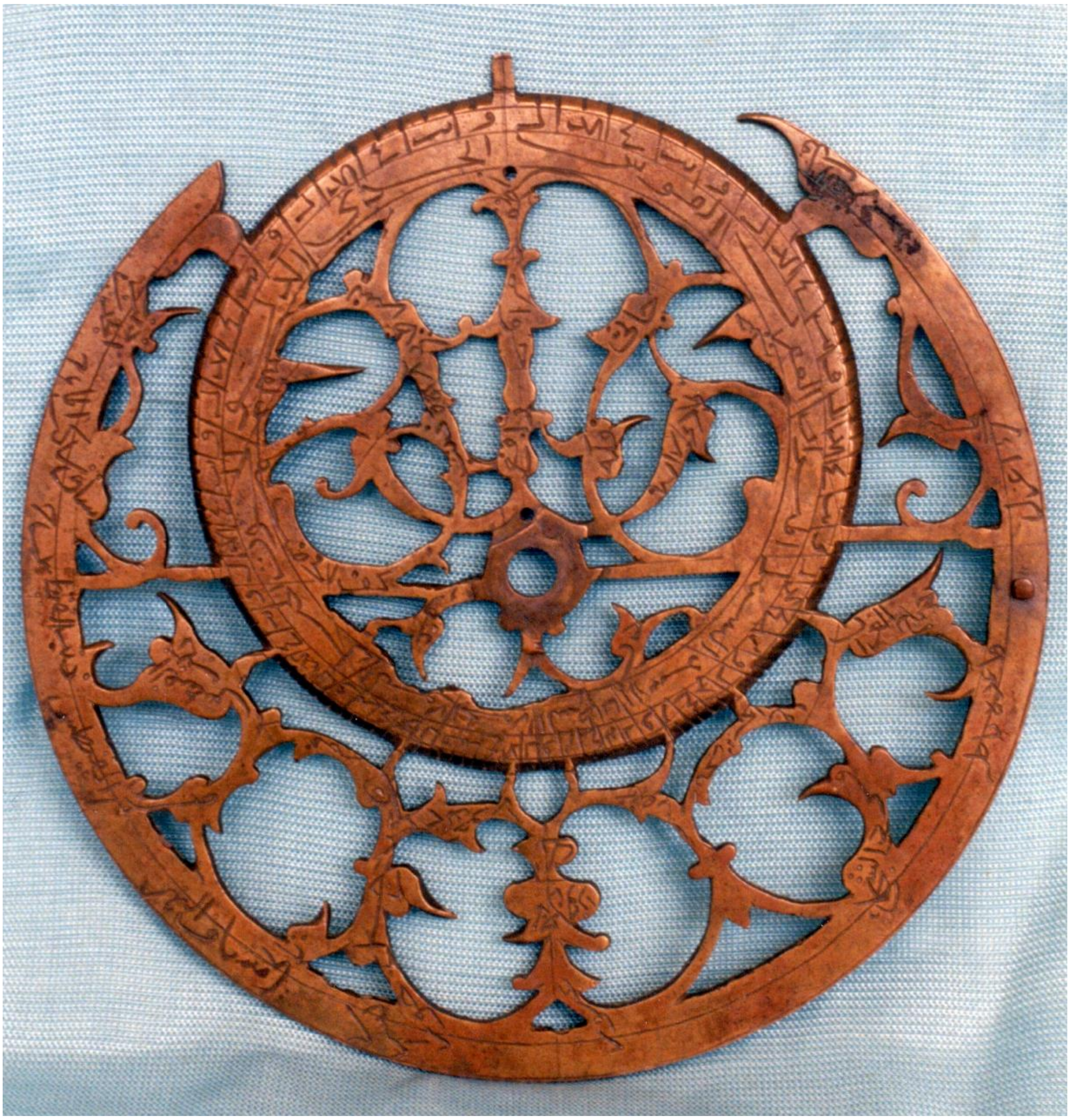

Figure A116.2 – Rete of the astrolabe (photo by S. R. Sarma)

There are some 30 star pointers carrying star names which are often drastically shortened.

Table A116-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus [Shamālī]*	ι Ceti

	Star Name	Identification
2	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
3	*Fam [al-Qayṭus]*	γ Ceti
4	*Ṣadr al-Qayṭus*	π Ceti
5	*Ghūl*	β Persei
6	*Tālī Masāfat al-Nahr*	γ Eridani
7	*Rijl al-Jawzā' al-Yusrā*	β Orionis
8	*Yad al-Jawzā' [al-Yusrā]*	γ Orionis
9	*Rijl al-Jawzā' [al-Yumnā]*	κ Orionis
10	*ᶜAbūr*	α Canis Majoris
11	?	α Canis Minoris
12	*Fard al-Shujāᶜ*	α Hydrae
13	*[Ẓahr al-] Dubb [al-Akbar]*	α Ursae Majoris
14	*Minkhar al-Shujāᶜ*	σ Hydrae
15	*Qā'idat al-Bāṭiya*	α Crateris
16	*Janāḥ al-Ghurāb*	γ Corvi
17	*Simāk Aᶜzal*	α Virginis
18	*Simāk Rāmiḥ*	α Bootis
19	*[Nayyir al-] Fakka*	α Coronae Borealis
20	*Qalb al-ᶜAqrab*	α Scorpii
21	*[Rās al-] Jāthī*	α Herculis
22	*[Rās al-] Ḥawwā'*	α Ophiuchi
23	*[Yad al-Ḥawwā al-] Muqaddam*	δ Ophiuchi
24	*[Nasr] Wāqiᶜ*	α Lyrae

	Star Name	Identification
25	*Nasr Ṭā'ir*	α Aquilae
26	?	
27	*[Dhanab al-] Dulfīn*	ε Delphini
28	*Dhanab [al-Dajāja]*	α Cygni
29	*Fam [al-Faras]*	ε Pegasi
30	*Dhanab al-Jadī*	δ Capricorni
31	*Sāq Sākib al-Mā' J[anūbī]*	δ Aquarii
32	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are three plates. On plates 1 and 2, altitude circles are drawn for each 6°. Azimuth arcs are drawn for each 15° below the horizon. There are lines for seasonal hours and dotted lines for equal hours drawn from the western horizon. Strangely there is no plate for 32°, the latitude of Lahore. It is possible that there were originally five plates in this astrolabe, and two of which are now missing.

Table A116-2 Plates

	φ	Longest Day
1a	18°	13;18 hours
1b	20°	13;20 hours
2a	27°	13;49 hours
2b	29°	13;52 hours
3a	72°	
3b	Tablet of horizons	

Geographical Gazetteer

The gazetteer is engraved in two circles providing the names, longitudes, latitudes and *inhirāf* for 40 places. The argument is engraved at the beginning of the outer circle, but not at the beginning of the inner circle. The zero symbol looks sometimes like the *abjad* symbol for 31.

Figure A116.3 – Geographical Gazetteer (photo by S. R. Sarma)

Table A116-3

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*	*Inḥirāf* *qiblah samt*
	Outer Circle			
1	Makka Muᶜaẓẓam	77;10	21;40	------
2	Madīnat Ṭayyiba	75;20	25;0	63;34 ?
3	Bayt al-Maqdis	66;30	32;15	45;18
4	Qayrawān	41;0	21;40	62;22
5	Jarmī Ḥabash	65;0	9;30	42;28
6	Miṣr	63;20	30;20	31;46
7	Iskandariyya	61;54	30;18	28;18
8	Quljum Kanār Darya	64;0	30;39	30;39!
9	ᶜAdan	76;0	11;0	84;10
10	Sanaᶜān	74;0	14;30	88;48
11	Sāwa	85;0	35;0	60;38
12	Qazwīn	85;0	36;0	62;22
13	Iṣfahān	86;40	32;25	49;40
14	Kāshān	86;0	34;0	55;29
15	Shīrāz	83;0	29;36	36;14
16	Ṭūs	92;30	36;0	84;51
17	Tūn	92;30	34;30	39;39
18	Harāt	94;20	34;30	36;51
19	Balkh	101;0	36;41	29;24
20	Bukhārā	97;39	39;36	40;3
21	Samarqand	99;16	39;31	16;57

	Place Name *al-bilād*	L *al-ṭūl*	φ *al-ᶜarḍ*	*Inḥirāf qiblah samt*
22	Qandahār	104;40	33;0	20;10
23	Kābul	105;0	34;30	20;28
	Inner Circle			
24	Dihlī	113;35	18;39 !	3;35
25	Akbarābād	115;0	26;43	0;0 !
26	Ajmīr	111;5	25;50	0;35
27	Aḥmadābād	110;20	23;0	3;37
28	Burhānbūr	112;20	21;21	8;40
29	Qalᶜahndar (Gulbarga?)	110;13	18;18	52;21
30	Dawlatābād	111;5	19;47	10;50
31	Aḥmadnakar	109;25	18;40	11;10
32	Bījābūr	113;26	17;17	15;0
33	Kalkandah	115;19	18;35	12;15
34	Rājmahal	121;5	25;15	4;10
35	Yabat ?	109;12	26;40	1;45
36	Gaur Bankāla	121;12	25;0	53;30
37	Banāras	114;20	27;0	1;35
38	Lāhūr	109;20	31;50	11;18
39	Multān	104;35	29;40	9;?
40	Bandar Sūrat	108;10	21;35	?;5

BACK

The rim of the upper half carries altitudes scales, divided in 1° and 6° and labelled as 6—90; 90—6. In the upper left quadrant are drawn 30 horizontal and 30 vertical

parallels, with each fifth highlighted by dots. A radial line is drawn from the centre to 45° on the arc. The upper right quadrant is divided by declination arcs into six unequal segments and the names of the related segments are engraved along the horizontal and vertical radii. Two curves are traced for the midday latitude of the sun at the latitudes 20° (roughly for Mecca) and 32° (for Lahore) with the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 20* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ 32.*

In the lower half are drawn shadow squares, for a base of 6 and 12 on the left and for a base of 7 on the right. The four scales are accompanied by the usual labels.

Figure A116.4 – Back of the astrolabe (photo by S. R. Sarma)

Inside the shadow squares is inscribed the table entitled *jadwal faḍl al-dawr* (excess of revolution).

The rim of the lower half is engraved with the scales of cotangents. These are followed by four semi-circular rows. The innermost row carries the names of the 28 lunar mansions. The next row is filled with the names of the 12 zodiac signs. In the following row, each sign is divided in 5 parts and numbered as 6, 12, 18, 24 and 30. In the last row each of these parts is divided thrice into units of 2°.

A117⊙ ASTROLABE ATTRIBUTABLE TO ḤĀMID

Not dated

Diameter 117 mm

Edinburgh, National Museum of Scotland (#1962.13)

CCA 89

Figure A117.1 – Front of the astrolabe (photo by S. R. Sarma)

COMPONENTS

Body with *kursī* (d. 117, h. 147, t. 7), shackle and ring, rete, 5 plates, alidade, pin and horse. The horse appears to be a modern replacement.

FRONT

The ring is plain and the shackle trifoliate. The *kursī* is solid and the profiles are made up of a lobe between two ogees. The finial is trifoliate, but the two horizontal petals are slightly extended and curved downwards. The surface is plain without any ornamentation. The limb is graduated in 1° and 6° and numbered clockwise in 6s from 6 to 90, separately in each quadrant.

Figure A117.2 – Rete of the astrolabe (photo by S. R. Sarma)

RETE

The peripheral Capricorn ring and the ecliptic ring are held together by the tracery that joins the various star pointers. Unlike in other astrolabes, the equinoctial bar is not represented here; the solstitial bar appears only in interrupted segments to which are attached some star pointers. The tracery which joins the star pointers is very symmetrical, but strangely not all the star pointers are engraved with their names. There is a small handle below the west point.

Table A117-1 Stars on the Rete

	Star Name	Identification
1	*Ṣadr al-Qayṭus*	π Ceti
2	*Ghūl*	β Persei
3	*ᶜAyn al Thawr* ?	α Tauri
4	*ᶜAyyūq*	α Aurigae
5	*Rijl [al-Jawzā' al-] Yusrā*	β Orionis
6	*Yad [al-] Jaw[zā' al-Yusrā]*	γ Orionis
7	*ᶜAbūr*	α Canis Majoris
8	*Shiᶜrā Shāmī*	α Canis Minoris
9	*Fard [al-Shujāᶜ]*	α Hydrae
10	*Qalb al-Asad*	α Leonis
11	*[Janāḥ al-] Ghurāb*	γ Corvi
12	*Simāk Aᶜzal*	α Virginis
13	*Simāk Rāmiḥ*	α Bootis
14	*Nayyir al-Fakka*	α Coronae Borealis
15	*Rās al-Hawwā*	α Ophiuchi
16	*Nasr Ṭā'ir*	α Aquilae
17	*?*	α Cygni

	Star Name	Identification
18	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are 5 plates, all with notches at the north point.

Table A117-2 Plates

	φ	Longest Day
1a	17°	12;38 hours
1b	18°	13;4 hours
2a	27°	13;43 hours
2b	29°	13;52 hours
3a	32°	14;8 hours
3b	36°	14;22 hours
4a	34°	14;14 hours
4b	38°	14;40 hours
5a	72°	
5b	Tablet of horizons	

On the first four plates, altitudes circles are drawn for each 6° and azimuth arcs for each 15° below the horizon. There are lines for seasonal hours and dotted lines for equal hours. On 1a, 1b, 2a and 2b, dotted lines for equal hours are drawn from the western horizon; on 3a, 3b, 4a and 4b, they are from both the horizons.

GEOGRAPHICAL GAZETTEER

Gazetteer is engraved in two circles, providing the names, longitudes and latitudes of 47 places roughly in the order of increasing longitudes. The argument occurs at the beginning of the first circle, but not at the beginning of the second circle. It is interesting

that Golconda is referred to here (no. 46) as Ḥaydarābād for the first time on an astrolabe.

Figure A117.3 – Geographical Gazetteer (photo by S. R. Sarma)

Table A117-3 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
1	Makka Muᶜaẓẓam	77;10	21;40
2	Madīnat Ṭayyiba	75;20	25;0
3	Bayt al-Maqdis	66;30	31;50

	Place Name	L	φ
4	Kūfa	79;30	31;30
5	Baghdād	82;0	38;55
6	Miṣr	63;20	30;20
7	Dimashq	70;44	33;35
8	Ḥalab	72;10	35;50
9	Baṣra	84;0	30;0
10	Marāgha	82;0	37;20
11	Tabrīz	82;0	38;0
12	Ardabīl	82;30	38;0
13	Shamākhī	84;30	40;50
14	Nakhjawān	81;15	38;40
15	Shūshtar	84;30	31;30
16	Shīrāz	88;0	29;36
17	Yazd	89;0	32;0
18	Nahāwand	83;55	34;20
19	Hamadān	83;0	35;0
20	Qazwīn	85;0	36;45
21	Jurbāzqān	85;35	34;15
22	Iṣfahān	86;40	32;25
23	Kāshān	86;0	34;0
24	Qumm	85;40	34;?
25	Rayy	86;0	35;0
26	Damāwand	87;20	36;10
27	Astarābād	89;35	37;50

	Place Name	L	φ
	Inner Circle		
28	Samnān	88;0	36;0
29	Sabzawār	91;30	36;5
30	Nishābūr	92;30	36;21
31	Ṭūs	92;30	37;0
32	Tūn	92;30	34;30
33	Qā’īn	93;20	33;40
34	Harat	94;20	34;30
35	Marw	97;0	34;40
36	Tālūn ?	104;50	34;10
37	Badakhshān	104;24	34;?
38	Balkh	101;0	36;0
39	Bukhārā	97;30	39;50
40	Samarqand	99;16	39; 31
41	Qandahār	104;40	33;0
42	Kashmīr	108;0	35;0
43	Kābul	104;40	34;30
44	Lāhūr	109;20	31;50
45	Bandar Sūrat	110;31	27;0
46	Ḥaydarābād	115;39	18;0
47	Bīchābūr	114;40	17;17

Back

On the back, the rim of the upper half carries altitude scales divided in 1° and 6° and numbered as 6—90; 90—6. The rim of the lower half bears the cotangent scales and their subdivisions.

The upper left quadrant is filled with 60 horizontal and 60 vertical parallels; attempt was made to emphasis ever fifth line with dots, but this has not been carried out uniformly. Semi-circles are drawn on both the radii and 3 quarter circles around the centre at 24 units (the arc of the obliquity of the ecliptic), 12 units (?) and 8 units (?). There is a radial line joining the centre to 45° on the arc and another line joining the inner terminals of the arc. The upper right quadrant is divided by 6 declination arcs and the related signs are marked by their serial numbers along the two radii. Two graphs are plotted to show the midday altitude of the sun throughout the year at latitudes 20° and 38°. The latter is accompanied by the label *khaṭṭ niṣf al-nahār bi-ᶜarḍ 38;* the former by *bi-ᶜ20.* While 20° can be the approximate latitude of Mecca (its traditional value is 21;40°), it is not clear which locality is represented by the latitude 38°.

In the lower half are engraved shadow squares, on the left for a base of 6 and 12 and on the right for 7 with the usual division of the scales and accompanied by the usual labels. Within these shadow squares is inserted the table of ‘the excess of revolution’ (*jadwal faḍl al-dawr*).

Alidade

The alidade is not graduated and sights are rather large.

Provenance

Formerly of the Sir John Findley Collection.

Figure A117.4 – Back of the astrolabe (photo by S. R. Sarma)

BIBLIOGRAPHY

Gunther 1932, no. 89, pp. 217-18;

Sotheby & co, *Sir John Findlay Collection: Catalogue of an Important Collection of Scientific Instruments* (the second and final part), Monday, 26 February 1962, lot 265, p. 67, plate XXV with the photos of the front and back.

A118⊙ ASTROLABE ATTRIBUTABLE TO ḤĀMID

Not dated, 17th Century

Diameter 77 mm

London, Science Museum (1938-437)

Figure A118.1 – Front of the astrolabe (photo by S. R. Sarma)

With a diameter of 77 mm, this is one of the smallest astrolabes; the workmanship is quite good, but the calligraphy is rather poor, especially in the geographical gazetteer. A graph for meridian altitude of the sun at Lahore's latitude of 32° is plotted on the back, but strangely no plate is made for this latitude. The solid *kursī* resembles the same in the astrolabe at Edinburgh (A117) and the rete displays similarities with the retes in many preceding astrolabes. It is therefore attributable to Ḥāmid.

COMPONENTS

Body with the *kursī* (d. 77, h. 102, t. 7.5), ring, shackle, rete (d. 64.5), 5 plates (d. 64.5), alidade (length 7.8), pin and horse.

FRONT

The ring has a diamond cross-section; shackle trifoliate; *kursī* is solid with lobed profiles and a trifoliate finial. The limb is divided in 2° and 10° and numbered clockwise in 10s from 10 to 360.

RETE

The slender Capricorn ring and the broader ecliptic ring are held together by the equinoctial bar which is counter-changed at the centre. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names. Each sign is divided into 5 units, but not numbered. Parts of the circles of equator and Cancer can be seen on the surface. Eighteen star-pointers are engraved with starkly abridged star names; several pointers are not named. There is a large round handle on the equinoctial bar close to the west point; the Capricorn index is well formed.

PLATES

There are five plates. On the latitude plates, altitude circles are drawn for every 6°; azimuth arcs are for 10° sometimes above the horizons and sometimes below. Plain lines for seasonal hours; dotted lines drawn from the western horizon for equal hours. The duration of the longest day is not mentioned on two plates; rough approximation in the rest.

Table A118-1 Plates

	φ	Longest Day
1a	34°	---
1b	36°	14 hours
2a	22°	13 hours
2b	40°	15 hours
3a	42°	15 hours
3b	Double projection	
4a	27°	---
4b	Tablet of ecliptic coordinates	
5a	Tablet of horizons	
5b	Tablet of horizons	

Figure A118.2 – Tablet of ecliptic coordinates (photo by S. R. Sarma)

Plate 5 is engraved with multiple horizons on both sides. In spite of its small size with a diameter of 64.5 mm, the tablet of ecliptic coordinates is engraved with latitude circles and longitude circles for each 6° and numbered very meticulously.

Figure A118.3 – Geographical gazetteer (photo by S. R. Sarma)

GEOGRAPHICAL GAZETTEER

The geographical gazetteer is engraved in two circles with the names (*bilād*), longitudes (*ṭūl*) and latitudes (*ᶜarḍ*) of 42 localities which include several Indian cities.

Table A118-2 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
1	Makka	77;10	21;40
2	Madīna	75;20	25;0

	Place Name	L	φ
3	Bayt al-Maqdis	66;30	31;50
4	?	83;0	26;15
5	Miṣr	69;20	30;20
6	ᶜAdan	76;0	11;0
7	Tibirīya	68;0	32;0
8	Dimashq	70;0	33;55
9	Baᶜālbak	70;45	33;15
10	Ḥalab	72;10	32;50
11	Qūniya	66;30	41;0
12	Irbīl	77;20	35;0
13	?	105;55	37;59
14	Kūfa	79;30	31;30
15	Baṣra	86;0	30;0
16	Shīrāz	88;0	30;0
17	Yazd	89;0	32;30
18	Ṭūs	92;30	36;0
19	Tūn	97;30	34;30
20	Balkh	100;0	36;41
21	Bukhārā	97;30	39;50
22	Samarqand	99;36	39;57
23	Badakhshān	104;24	37;10
24	Khutan	87;0	47;30
25	Tubbat	108;0	40;0
26	Kashmīr	108	35;0

	Place Name	L	φ
27	Kābul	104;40	35;0
	Inner Circle		
28	Qandahār	106;40	33;0
29	Multān	106;35	29;40
30	Lāhūr	109;20	31;50
31	Dihlī	110;45!	28;47
32	Akra	114;0	27;13
33	Jawnbūr	119;40	36;36! it should be 26;26
34	Kawāliyar	115;0	26;29
35	Ajmīr	110;0	24;0
36	Mīwāt	117;10	32;50
37	Bānārasī	117;20	26;55
38	Qannawj	115;50	26;35
39	Māndū	117;4	22;4
40	Burhā[n]būr	109;0	20;31
41	Aḥmad[ā]bād	111;9	19;0
42	Dawlatābād	111;0	20;30

Figure A118.4 – Back of the astrolabe (photo by S. R. Sarma)

BACK

The rim of the upper half carries altitude scales graduated in 1° and 5° and labelled 5---90; 90---5. The trigonometric quadrant in the upper right is engraved with 30

horizontal parallel lines with every fifth highlighted. The solar quadrant in the upper right is divided by the declination arcs into 18 zones, one for each 10°. The corresponding signs are marked by their serial numbers along the two radii. A graph for the meridian altitude of the sun in all seasons is dawn for the latitude 32° with the label *khaṭṭ niṣf al-nahār ᶜarḍ 32.*

Shadow squares are drawn in the lower half, on the left for the base of 12 and on the right for the base of 7; the scales are divided accordingly and accompanied by the usual labels.

The rim on the lower half carries cotangent scales and their subdivisions. These scales are followed by four semi-circular rows. The first two are engraved with the names of the first 6 zodiac signs from *al-Ḥamal* to *al-Sunbula* and the 14 corresponding lunar mansions; rows 3 and 4 contain the names of the signs from *al-Mīzān* to *al-Ḥūt* and the 14 corresponding lunar mansions.

ALIDADE

Alidade is plain and not graduated. The pin is original, but the wedge is a replacement.

A119 ASTROLABE ATTRIBUTABLE TO ḤĀMID[513]

Diameter 132 mm

PLU: ex-Sir John Findlay Collection

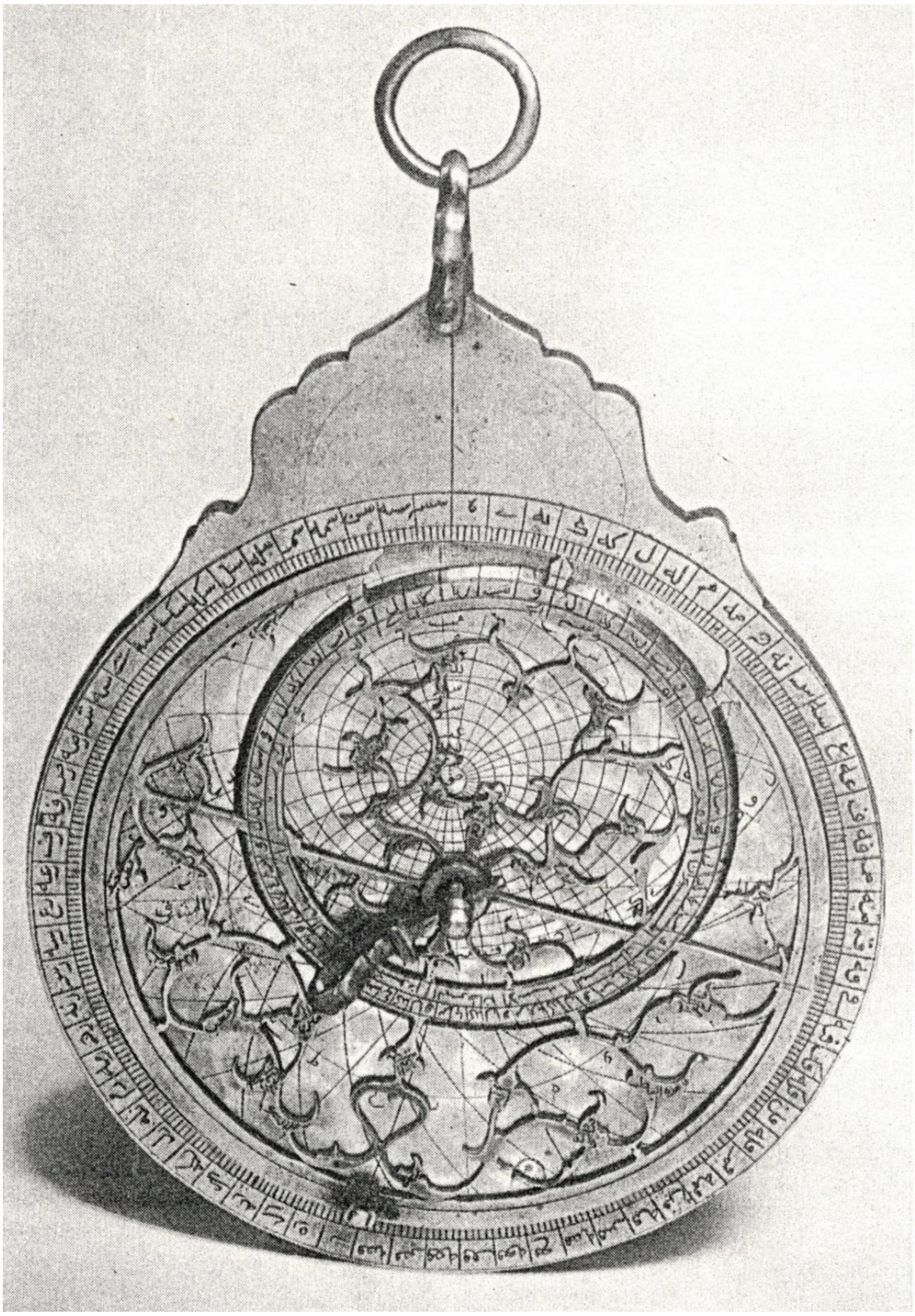

Figure A119.1 – Front of the astrolabe (photo from Sotheby's catalogue)

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513 Entry based on Sotheby & co, *Sir John Findlay Collection: Catalogue of an Important Collection of Scientific Instruments* (the second and final part), Monday, 26 February 1962, lot 264, p. 66, plate XXIV with the photos of the front and back.

The profiles of the *kursī* and the design of the rete strongly suggest that this astrolabe may have been made by Ḥāmid, even though the two upper quadrants on the back are rather unusual.

COMPONENTS

Body with *kursī* (d. 132 mm), shackle and ring, rete, 4 plates, alidade, pin, wedge and suspension cord.

FRONT

The suspension cord is of plaited silk threads. The ring is plain; the shackle also appears to be plain. The solid *kursī* has profiles exactly like those in A111, A112, A113and A115. The surface of the *kursī* is plain in the front: the vertical diameter of the astrolabe is extended on it and also a semicircle is drawn faintly. On the back of the *kursī* is the name Muḥammad Bāqir bin Siddiq al-Dawlah in relief in large letters, presumably of the man for whom the astrolabe was made. The area around the raised letters is painted black. The limb is divided in 1° and 5° and numbered in 5s from 5 to 360.

RETE

The slender Capricorn ring and the wider ecliptic ring are held together by the equinoctial bar which has counter changes at its intersection with the ecliptic ring on the left and at the centre. The 32 named star pointers are joined by an arabesque tracery.

PLATES

There are four plates; the first three are calibrated for latitudes 29°, 38°, 32°, 34°, 36°, 37°. The fourth plate carries tablets of horizons on both sides. Two of the latitudes, 29° and 32°, belong to Delhi and Lahore respectively. The others fall outside India proper. This is not unusual for Ḥāmid; he has plates for 34°, 36° and 38° in his other astrolabes also. On the plate which is visible under the rete in the photo, altitude circles are drawn for every 6°, azimuth arcs for every 10° above the horizon as also lines for seasonal hours and lines for equal hours drawn from the western horizon.

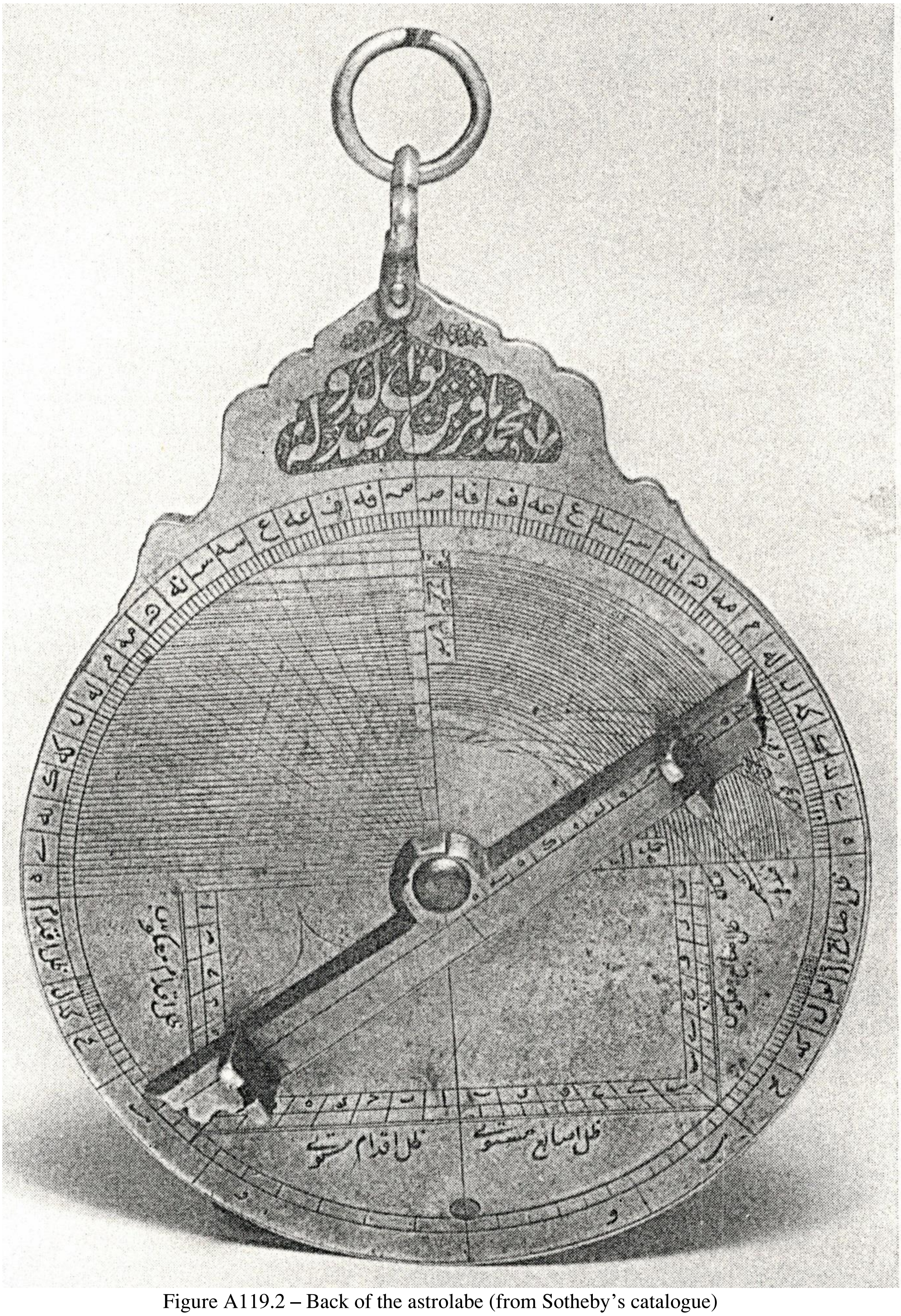

Figure A119.2 – Back of the astrolabe (from Sotheby's catalogue)

Geographical Gazetteer

The catalogue states that the geographical gazetteer on the inner side of the mater provides the names, longitudes, latitudes and *inḥirāf* of 52 towns.

Back

The rim of the upper half carries altitude scales which are divided in 1° and 5° and numbered as 5—90; 90—5. In the upper left quadrant are drawn 60 horizontal lines; which are followed by 4 horizontal lines at unequal intervals. Radian lines are drawn from the centre to every 5° on the arc. In the upper right quadrant are drawn declination arcs for every 6° of solar longitude; the names of the related signs are written in small boxes along the two radii. Upon these are traced the graphs of the azimuths of *qibla* for Multān, Kashmīr, Qandahār, Tūs, Iṣfahān, Baṣra and Madīna.

In the lower half are drawn the shadow squares, on the left for a base of 7 and on the right for 6 (12) with the usual labels. The rim of the lower half carries cotangent scales and their subdivisions with the labels *ẓill aqdām* on the left and *ẓill aṣābi*ᶜ on the right.

Alidade

The alidade has ornate ends, ornate centre piece and ornate sighting plates; the right hand side carries a sexagesimal scale numbered in 5s as 5, 10, 5, 20 … 5, 60. The wedge is of the usual design; its head and neck are bent backwards to form a loop.

Bibliography

Sotheby & co*, Sir John Findlay Collection: Catalogue of an Important Collection of Scientific Instruments* (the second and final part), Monday, 26 February 1962.

A120 ASTROLABE ATTRIBUTABLE TO ḤĀMID

Diameter 96 mm

PLU

Figure A120.1 – Front of the astrolabe
(photo courtesy Museum of the History of Science, Oxford)

In the archives of the Museum of the History of Science at Oxford, there are photos of the front and back of this astrolabe, and also somewhat faint photocopies of the gazetteer, and the two sides of the six plates, together with the following note in the handwriting of Francis Maddison:

> Indo Persian astrolabe / Not signed / ? c 1700 / Brass (1 varnished paper plate) / Diameter 96 mm.
>
> Brought to FRM [= Francis R. Maddison] for examination on 29 October 1985 by: / ***[514] Edinburgh / Neg. ref. no. 85 – 46ab 35.S.

There is no doubt that this astrolabe was produced in the Lahore family, but it is difficult to decide by whom. In the solar quadrant on the back, there are two graphs of the solar meridian altitude at latitudes 21° (Mecca) and 32° (Lahore). Ḥāmid drew the graph for Mecca on many of his astrolabes. As many as six of his astrolabes carry just one single graph for Mecca at 20°. On some others, graphs are drawn for the latitude of 21° along with other latitudes like 32° for Lahore. Therefore, it is quite likely that the present astrolabe was made by Ḥāmid.

Components

Body with *kursī* (d. 96), shackle and ring, rete, 6 plates, alidade, pin and horse.

Front

The *kursī* looks like a royal crown in outline, with trifoliate finial. The limb is rather broad; it is divided in 1° and 6° and numbered from 1 to 90, separately in each quadrant.

Rete

The Capricorn ring and the ecliptic ring are held together by the equinoctial bar, which has counter changes at its two intersections with the ecliptic ring. The ecliptic ring is divided into the 12 zodiac signs and labelled with their names; each sign is divided into 5 and 10 divisions and numbered in 6s. Traces of the circles of the equator

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514 Here are the name and address of a person, but the names of individual owners are not mentioned in this Catalogue as a matter of policy.

and of the Tropic of Cancer are visible on the surface of the ecliptic ring. There are about 30 star pointers.

PLATES

There are 6 plates serving 23° and 25°; 27° and 29°; 32° and 1°+72°+90°; 21° and 18°+30°; tablet of ecliptic coordinates and tablet of horizons. The values of the hours of the longest day are difficult to read in the faint photocopies. On plates 1-5, altitude circles are drawn for each 3°, azimuth arcs for each 10°, sometimes below the horizon and sometimes both above and below the horizon, and plain lines for seasonal hours and dotted lines for equal hours from the western horizon. The tablet of the ecliptic coordinates and the tablet of horizons are endowed with the usual labels.

GEOGRAPHICAL GAZETTEER

In the geographical gazetteer, arranged in a spiral form, the names, geographical longitudes and latitudes of 30 places starting from Mecca are engraved.

BACK

The rim of the upper half carries the altitude scales which are divided in 1° and 6° and numbered as 6—90; 90—6. The upper left quadrant contains a sine-cosine grid with 30 vertical and 30 horizontal parallels, with each fifth line being dotted. In the upper right quadrant are 18 solar declination arcs, one for each 10° of the solar longitude. Every third of the arcs, which forms the boundary between two signs, is highlighted with dots. The serial numbers of the related signs are marked along the two radii. Two graphs of the solar meridian altitude are drawn across the quadrant for latitudes 21° and 32°, i.e. for Mecca and Lahore. The former is accompanied by the label *ᶜarḍ 21* and the latter *ghaṭ* (sic!) *niṣf al-nahār ᶜarḍ 32.*

In the lower half are shadow squares on the left for a base of 12 and on the right for a base of 7. The two scales on the left are divided in 6 and 12 units and numbered 2, 4, 6, 10, 12, while the two scales on the right are divided in 7 units and numbered serially from 1 to 7. In the two corners below are the labels *ẓill sullam.* The four scales are accompanied by the usual labels.

The rim of the lower half bears two cotangent scales. The divisions in the scale on the left are numbered 6, 12, …60, followed by the label *ẓill aṣābiᶜ*. The divisions in the scale on the right are also numbered in the same manner, but followed by the label *ẓill*

aqdām. Each division in these scales is divided into 5 parts in the following semi-circular row.

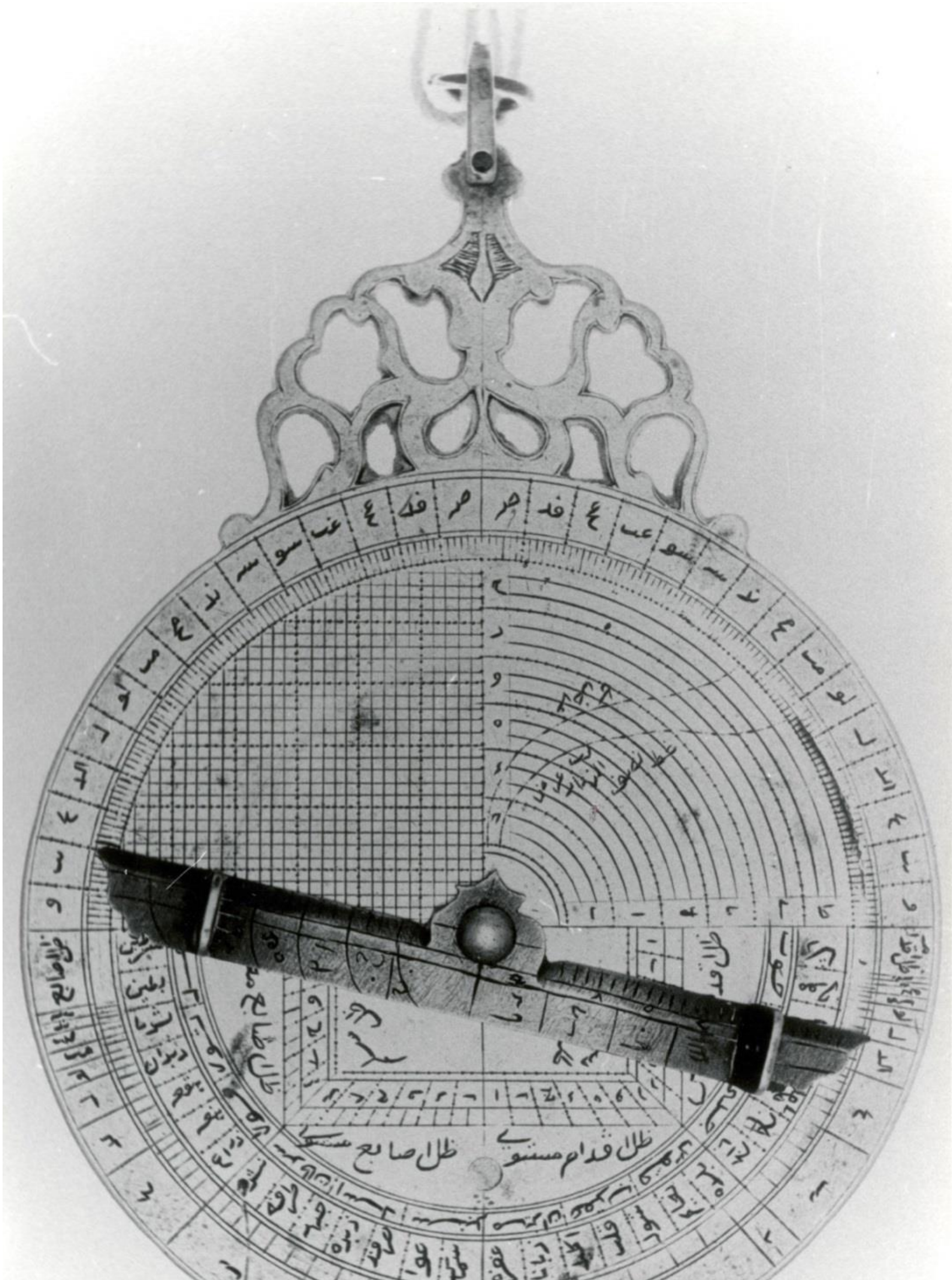

Figure A120.2 – Back of the astrolabe (photo courtesy Museum of the History of Science, Oxford)

Then follow two semi-circular rows engraved with the names of the 28 lunar mansions and the names of the 12 signs respectively.

The semi-circular rows on the back are separated by double lines and the divisions in these rows are often separated by dotted lines.

ALIDADE

The alidade has ornate terminals and an ornate centre-piece. The right hand side carries a sexagesimal scale to match with the divisions in the upper left quadrant. There are also markings for a sundial here. The left hand side is divided by arcs of solar declination and marked with the serial numbers of the signs.

The wedge is quite long, measuring about 50 mm and appears to be shaped like a horse's head with a high neck.

JAMĀL AL-DĪN

Jamāl al-Dīn ibn Muḥammad Muqīm (*fl.* 1666-1691), the last member of the Lahore family, is known from four astrolabes which he produced between 1077/1666-67 and 1103/1691-92. He may have produced more than four astrolabes during this quarter century, but these have not come to light. Even among the four extant astrolabes, the last two are not accessible. Of the remaining two, A001 is an ordinary astrolabe, while A121 is an impressive production with a zoomorphic rete and *qibla*-indicating lines engraved along with the regular gazetteer. Two other astrolabes are attributed to him: a common astrolabe (A126) and a universal astrolabe (A125). The latter is a rare *shakkāziyya* type of universal astrolabe and resembles closely the unique astrolabe made by Ibn al-Sarrāj in Aleppo in 729/1328-29, which David King considers to be 'the most sophisticated [instrument] ever made between Antiquity and 1600'.[515]

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515 King 2005, p. 694.

A121⊙ ZOOMORPHIC ASTROLABE AND QIBLA INDICATOR BY JAMĀL AL-DĪN 1077 AH (AD 1666-67)

Diameter 251 mm

London, Science Museum (#1985-2077)

Répertoire 1

Figure A121.1 – Front of the astrolabe (photo by S. R. Sarma)

In this ambitious astrolabe, Jamāl al-Dīn incorporates a zoomorphic rete following the footsteps of his father Muḥammad Muqīm, a *zawraqī* horizon in emulation of his uncle Ḍiyā’ al-Dīn Muḥammad, and a *qibla* indicator which his brother Ḥāmid imitated in a grander scale twenty years later (A112). But the astrolabe lacks the elegance of the astrolabes of Muqīm and Ḍiyā al-Dīn.

COMPONENTS

Body with *kursī* (d. 251, h. 340, t. 11), shackle and ring, rete (d. 228) for 42 stars, 7 plates (d. 228), alidade (l. 230), pin and horse (replacement).

FRONT

The ring has a diamond-shaped cross-section; the shackle also has a similar cross-section and a trifoliate form. The *kursī* is reticulated, with tulip-like forms in the profiles and a small rectangular cartouche in the middle; the finial is trifoliate.

The limb is divided in 1° and 6° and labelled in 6s from 6 to 90, separately in each quadrant.

ZOOMORPHIC RETE

The two rings of Capricorn and ecliptic are joined by the complete equinoctial bar, with counter changes at its intersections with the ecliptic circle and by the complete solstitial bar, without any counter change.

The ecliptic circle is divided into 12 signs of the zodiac and labelled with their names; each sign is divided into groups of 6° and numbered, the bevelled edge of the ecliptic ring is divided into 1°. Floral tracery joins the 42 star-pointers, some of which have zoomorphic or anthropomorphic forms.[516] Because of these forms, the exact positions of stars are not always properly shown. In some places, small round holes are made to indicate the exact positions of stars.

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516 The Répertoire mentions 67 star pointers which is clearly an error.

Figure A121.2 – Rete of the astrolabe (photo by S. R. Sarma)

Table A121-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
2	*Baṭn [al-Ḥūt]*	β Andromedae
3	*Rijl al-Musalsala*	γ Andromedae
4	*Fam al-Qayṭus*	γ Ceti

	Star Name	Identification
5	*Ṣadr al-Qayṭus*	π Ceti
6	*Rās al-Ghūl*	β Persei
7	*Tālī Masāfat al-Nahr*	γ Eridani
8	*ᶜAyn al-Thawr*	α Tauri
9	*ᶜAyyūq*	α Aurigae
10	*Rijl al-Jawzā’ [al-Yusrā]*	β Orionis
11	*Yad al-Jawzā’ [al-Yusrā]*	γ Orionis
12	*Yad al- Jawzā’ [al-Yumnā]*	α Orionis
13	*Rijl al-Jawzā’ [al-Yumnā]*	κ Orionis
14	*Shiᶜrā Yamānī*	α Canis Majoris
15	*Shiᶜrā Shāmī*	α Canis Minoris
16	*Fard al-Shujāᶜ*	α Hydrae
17	*Qalb al-Asad*	α Leonis
18	*Dubb Akbar*	α Ursae Majoris
19	*Qāᶜidat al-Bāṭiya*	α Crateris
20	*ᶜAnāq*	ζ Ursae Majoris
21	*Janāḥ al-Ghurāb*	γ Corvi
22	*Simāk Aᶜzal*	α Virginis
23	*Simāk Rāmiḥ*	α Bootis
24	*Nayyir al-Fakka*	α Coronae Borealis
25	*ᶜUnuq al-Ḥayya*	α Serpentis
26	*Qalb al-ᶜAqrab*	α Scorpii
27	*Rukbat Ḥawwā’*	ζ Ophiuchi
28	*Rijl al-Muqaddam*	α Ophiuchi

	Star Name	Identification
29	*Rās al-Jāthī*	α Herculis
30	*Rās al-Ḥawwā’*	α Ophiuchi
31	*ᶜAyn al-Tinnīn*	γ Draconis
32	*Nasr Wāqīᶜ*	α Lyrae
33	*Minqār al-Dajāja*	β Cygni
34	*Nasr Ṭā’ir*	α Aquilae
35	*Dhanab al-Dulfīn*	ε Delphini
36	*Dhanab al-Dajāja*	α Cygni
37	*Fam al-Faras*	ε Pegasi
38	*Sāq Sākib al-Mā’ J[anūbī]*	δ Aquarii
39	*Dhanab al-Qayṭus Sh[amālī]* ι Ceti	
40	*Mankib al-Faras*	β Pegasi
41	*Surrat al-Faras*	δ Pegasi
42	*Kaff al-Khaḍīb*	β Cassiopeiae

Of these, 26 star pointers are given zoomorphic shape. Here Jamāl al-Dīn follows the example of his father Muḥammad Muqīm who created two splendid zoomorphic astrolabes (A023 and A051) and chooses nearly the same stars for zoomorphic shape, but his forms lack the elegance of his father’s work. As in the case of Muqīm’s astrolabes, here also we shall describe the zoomorphic shapes and explain their significance, in the same sequence as the stars are listed above. For each star, we shall provide first the Arabic name of the star as engraved on the astrolabe and its literal meaning and show how Jamāl al-Dīn lends a visual form to this meaning.

The first major constellation south of the ecliptic is the sea-monster Cetus, transliterated as *al-qayṭus* in Arabic, which is visualized on Islamic celestial globes with

‘a snarling dog’s head, bird’s feet, and a feathered fish tail’.[517] Muqīm just depicts the fish tail with the two fins (northern and southern) and the dog’s head, placing the appropriate stars in these parts. The tips of the tail fins become the pointers to the stars called respectively after these. Jamāl al-Dīn imitates this.

1. *Dhanab al-Qayṭus J[anūbī]* (southern tail of Cetus), shown as the tip of the southern fin of the fish tail.

2. *Baṭn [al-Hūt]* (belly of the fish), head of a fish

4. *Fam al-Qayṭus* (mouth of Cetus) snarling dog’s head

7. *Talī Masāfat al-Nahr* (valley or expanse of the river [Eridanus]), the river is shown as an arc, from which projects the thin star pointer.

8. *ᶜAyn al-Thawr* (eye of the bull), bull’s head with horns and an engraved eye.

10-11-12-13. The four stars are located in the two hands and the two feet of Orion. Muqīm depicts the hands skillfully with the three last fingers folded, and the index finger outstretched to form the star pointer. He depicts the legs through tapering shoes. Jamāl al-Dīn’s figures can be understood only when one knows Muqīm’s figures.

14. *Shiᶜrā Yamānī* (the southern Shiᶜra, α Canis Majoris, Sirius), dog’s head.

15. *Shiᶜrā Shāmī* (the northern Shiᶜra, α Canis Minoris, Procyon), dog’s head.

16. *Fard al-Shujāᶜ* (the isolated one of the serpent), snake’s head.

19. *Qā’idat al-Bāṭiya* (bottom of the cup), a bucket with vertical serrations.

20. *Janāḥ al-Ghurāb* (wing of the raven), full body of a crow.

29. *Rās al-Jāthī* (the head of the kneeling man, i.e. Hercules), a stiff bust of a human figure with a crown.

30. *Rās al-Ḥawwā’* (the head of the serpent charmer), similar human figure as above, but upside down.

31. *ᶜAyn al-Tinnīn* (the eye of the dragon), a grinning fish.

33, 36. *Minqār al-Dajāja* (the bird’s beak) and *Dhanab al-Dajāja* (the bird’s tail), both names engraved on a soaring bird.

34. *Nasr Ṭā’ir* (the flying eagle), bird with engraved eye and engraved wing feathers.

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[517] Savage-Smith 1985, p. 187.

36. *Dhanab al-Dulfīn* (the dolphin's tail), head of a fish.

37, 40, 41. *Fam al-Faras* (the mouth of the horse), *Mankib al-Faras* (shoulder of the horse) and *Surrat al-Faras* (the navel of the horse) are engraved on the figure representing the shoulder and head of a horse; a longish piece projecting out of the horse's mouth serves as the star pointer.

39. *Dhanab al-Qayṭus Sh[amālī],* (northern tail of Cetus), shown as the tip of the northern fin of the fish tail.

42. *Kaff al-Khaḍīb* (the dyed hand), a female face engraved on the equinoctial bar.

Zawraqī Horizon

There is a slender arc of the horizon which passes through the two intersections of the ecliptic and equinoctial bar and reaches up to the circle of Capricorn on both sides. This arc, together with the upper half of the solstitial bar, forms a ship with its mast.

This arc represents the *zawraqī* horizon of presumably latitude 40°. There are four labels related to this horizon. Where it touches the Capricorn ring above the west point, there is a label on the Capricorn ring which reads *ufq mujassam gharbī* (solid horizon western). On the opposite side, where the horizon arc touches the Capricorn ring above the east point, there is another label on the Capricorn ring which is difficult to decipher: it can be either *ufq sharqī mujassam* (solid horizon eastern) or *ufq sharqī ᶜarḍ m* (eastern horizon, latitude 40°). On the eastern segment of the horizon which is inside the ecliptic ring is written *ufq sharqī* (eastern horizon) and on the western segment *ufq gharbī* (western horizon).

There is a label on the solstitial bar above the arc and another on the Capricorn ring where the lower part of the solstitial ring touches; I cannot decipher either one completely. This *zawraqī* horizon is to be used with the plate 4b which will be described below.

Plates

There are seven plates; on the first four altitude circles are drawn for each 1° and azimuth arcs below the horizon for each 6°. There are lines for seasonal hours; lines for equal hours are drawn generally from the western horizon; in a few cases from the western as well as from the eastern horizons. The durations of the longest day at different latitudes are rough approximations, given only in hours.

Table A121-2 Plates

	φ	**Longest day**
1a	23°	13 hours
1b	27°	13 hours
2a	29°	13 hours
2b	32°	14 hours
3a	34°	14 hours
3b	36°	14 hours
4a	38°	14 hours
4b	40°	14 hours
5a	21°	13 hours
5b	Double projection for 18° and 48°.	
6a	Triple projection for 0°, 72°, 90°.	
6b	Markings for determining the astrological 'projections of the rays' at latitudes 32° and 36°with curves for each 6° of latitude.	
7a	Tablet of ecliptic coordinates with the label *ṣafīḥat mīzān al-ᶜankabūt*	
7b	Tablet of horizons with the label *ṣafīḥa āfāqī*	

Plate 7 is engraved with the tablet of ecliptic coordinates on the obverse. Here the latitude circles are drawn for every 2°, but not numbered systematically. The longitude arcs are drawn for every 6° and numbered from 6 to 30, separately in each zodiac sign. But the ecliptic circle with the names of the signs is not drawn. The label reads *ṣafīḥat mīzān al-ᶜankabūt*.

The reverse side of this plate is engraved as the tablet of horizons with the label *ṣafīḥa āfāqī.* Here half-horizons for every 1° are drawn in four sets at intervals of 4° in the following manner:

2 6 10 … 58 62 66;30

3	7	11	…	59	63	66;30
4	8	12	…	60	64	66;30
5	9	13	…	61	65	66;30

Declination scales are drawn on either side of the equator between the equator and the tropics; these are divided in 3° and 6°, and numbered 6, 12, 18, 23;30, the last value being the obliquity.

Plate 5b carries the double projections for latitudes 18° and 48° in the two halves.

On plate 6a, one half carries the projections for 0° (label *lā ʿarḍ lah*) and 72° (*ʿarḍ 72*), and the other half for latitude 90° (label *ʿarḍ tisʿūn*).

Plate 4b appears to have been designed for use along with the *zawraqī* horizon on the rete, although it is somewhat different from similar plates in Ḍiyā'al-Dīn's astrolabes. Besides the concentric circles of Capricorn, equator and Cancer, the ecliptic circle is drawn in two bands. The inner band should have been divided into the 12 signs of the zodiac, but the divisions are not completely marked. The outer band is divided into units of 6°. As on other plates, altitude circles are drawn for each 1° and the azimuth arcs for each 6° below the horizon. Lines for seasonal hours; lines for equal hours are drawn from the western horizon up to the eastern horizon and once again from the eastern horizon to the western.

Figure A121.3 – Plate 4b for latitude 40° (photo by S. R. Sarma)

The names of 19 stars are written at approximately the same places as in the rete when it is at rest, but their exact locations are not marked. The stars are *Dhanab al-Qayṭus* (β Ceti), *Fam al-Qayṭus* (γ Ceti), *ᶜAyn al-Thawr* (α Tauri), *Yamānī* (α Canis Majoris), *Shāmī* (α Canis Minoris), *Minkhar al-Shujāᶜ* (σ Hydrae), *Fard al-Shujāᶜ* (α Hydrae), *Qāᶜidat al-Bāṭiya* (α Crateris), *ᶜAnāq* (ζ Ursae Majoris), *Simāk Aᶜzal* (α Virginis), (?), *Fakka* (α Coronae Borealis), *Rāmiḥ* (α Bootis), *Wāqiᶜ* (α Lyrae), *Minqār al-Dajāja* (β Cygni), *Nasr Ṭā'ir* (α Aquilae), *Fam al-Faras* (ε Pegasi), *Dhanab al-Jadī* (δ Capricorni), *Kaff al-Khaḍīb* (β Cassiopeiae).

Geographical Gazetteer

The inner side of the mater is divided into two halves by the north-south line. On the left half, a gazetteer for 80 localities is engraved in four concentric semi-circles. It

is arranged according to climates. The headings mentioning the climates are written in a circular band above each circle. In the first such band, the boundaries of each climate are marked by a special symbol, but not in other bands. Therefore, in the second, third and fourth circles, it is difficult to know where one climates end and a new one begins. The arguments are in the first cells on the left and the gazetteer has to be read from the left to the right.

Figure A121.4 – Geographical gazetteer (photo by S. R. Sarma)

Table A121-3 Geographical Gazetteer

	Place Name	L	φ
	First Circle		
[-I] *az khaṭṭ istiwā’ tā iqlīm awwal* (from the equator up to the first climate)			
1	Sāḥil Baḥr Awqiyānūs	11;0	0;0
2	Jazīra Qanbala	21;0	3;0
3	Jamkūt	177;0	5;0
4	Kukūh	31;10	10;0

	Place Name	L	φ
5	ᶜAdan	26;0[518]	11;0
6	Marbāṭ?	42;0	14;0
7	Sarāndīb	130;0	10;0
[I] *mabdā’ iqlīm awwal wa ᶜarḍ 12;40 wa aṭwal nahār 12;48* (beginning of the first climate and latitude 12;40 and the longest day 12;48 [hours])			
8	Bazza az Barbar	10;5	14;0
9	Sanᶜā’ Dār al-Mulk Yaman	77;0	14;30
10	Jazīra Damtab ?	71;0	14;0
11	Dabīl	74;20	14;10
12	Damār	77;15	13;30
13	Janad	75;30	13;30
14	Sawmnāt	106;0	17;0
15	Mujam	74;14	17;15
16	Jurash	77;50	17;15
17	Zaytūn	154;0	17;15
18	Hālī ibn Yaᶜqūb	77;20	18;30
19	Bījāpūr	105;30	17;20
[II] *iqlīm dūyum ᶜarḍ 20;30 aṭwal nahār 13;15* (second climate, latitude 20;30°, longest day 13;15 hours)			
20	Dawlatābād	111;0	20;30
21	Burhānpūr	113;0	21;0
22	Makka Muᶜaẓẓam	77;10	21;40
23	Madīnat Tayyiba	75;20	25;0

518 Longitude 26;0° is too low; it should be 56;0°.

	Place Name	L	φ
24	Ṭā’īf	77;30	21;20
25	Qannawj	114;50	26;20
26	Banāras	117;20	26;15
27	Akbarābād	115;0	26;43
28	Jawnpūr	119;6	26;26
29	Ujjayn	110;50	23;30
30	Jadda	76;0	21;0
31	Kawāliyar	114;0	26;29
	Second Circle		
[II] *tatimma iqlīm dūyum* (continuation of the second climate)			
32	Aḥmadābād	108;40	23;14
33	Kanbāyat	109;20	26;20
34	Ajmīr	111;5	26;0
35	Shīrāz	88;0	29;36
36	Hurmuz	92;20	25;0
[III] *mabdā’ az iqlīm siwum ʿarḍ 27;15 aṭwal nahār 13;45* (beginning of the third climate, latitude 27;15°, longest day 13;45 hours)			
37	Jahānābād	113;0	29;0 for Shāhjahānābād !
38	Thānīsar	112;0	20;10!
39	Pānīpat	113;20	28;52
40	Badāūn	114;59	27;32
41	Hānsī	112;25	29;45
42	Lāhūr	109;20	31;50
43	Multān	107;25	29;40

	Place Name	L	φ
44	Iṣfahān	87;40	32;35
45	Qayrawān	41;0	31;0
46	Bayt al-Maqdis	66;30	31;50
47	Yazd	89;0	32;0
48	Basra	84;0	30;0
49	Awadh	118;6	27;32
50	Fīrūzābād	87;30	28;10
51	Bakar	85;0	27;40
52	Qandahār	107;40	33;0
53	Sālkūt	109;0	33;0
54	Sirhind	111;33	30;30
	Third Circle		
[III] *tatimma iqlīm siwum* (continuation of the third climate)			
55	Kirmān	91;30	30;5
56	Kūfa	79;30	31;30
57	Baghdād	31;30[519]	33;25
[IV] *mabdā' az iqlīm chahārum ʿarḍ 33;40 aṭwal nahār 14;6* (Beginning of the fourth climate, latitude 33;40°, the longest day 14;6 hours)			
58	Mashhad	92;30	36;0
59	Qazwīn	85;0	36;45
60	Tabrīz	82;0	38;0
61	Hamadān	83;0	35;10

[519] An absurdly low value; other gazetteers mention values between 70;0 and 80;0.

	Place Name	L	φ
62	Kashmīr	108;0	35;0
63	Kābul	104;40	34;30
64	Ghazna	104;20	35;3
65	Balkh	101;0	36;11
66	Harat	94;20	34;30
67	Samarqand	99;30	36;30
68	Marw	94;20	36;30
69	Ṭūs	84;20	37;0
	Fourth Circle		
[IV] *tatimma iqlīm chahārum* (continuation of the fourth climate)			
70	Bukhārā	97;30	36;50
71	Rayy	86;20	34;0
72	Tubbat	104;40	34;30
[V] *mabdā' az iqlīm panjum ᶜarḍ 39;6 aṭwal nahār 14;14* (beginning of the fifth climate, latitude 39;6°, longest day 14;14 hours)			
73	?	92;30	41;0
74	Kāshān	81;35	42;0
75	Farghāna	102;0	42;20
76	Khutan	102;20	42;0
77	Badakhshān	84;34	37;10
78	Kashghar	106;30	44;0
[VI] *mabdā'az iqlīm shashum ᶜarḍ 43;30*) (beginning of the sixth climate, latitude 43;30°)			
79	Harqala	67;20	46;30
80	?	?	?

In the last annulus, around the central hole there is some writing, which is partly rubbed off by the alidade and cannot be deciphered.

Figure A121.5 – Qibla map on the mater (photo by S. R. Sarma)

QIBLA MAP

On the right hand side of the mater is engraved a unique map showing the directions of several Indian towns towards Mecca. On this map, David King remarks as follows:

> A grid based on an orthogonal projection would have the parallels of latitude projected as family of parallel lines (whose distance from the equator varies with the sin φ) and the meridians as a family of ellipses (cutting the equator at a radial distance varying with Sin ΔL, where ΔL is the longitude difference from the central meridian). Although I am not aware of any text that proposes such a grid either for a world-map or any kind of map for finding qibla, the method is graphically demonstrated on an instrument, namely an astrolabe dated 1077 J [= 1666/7] by Jamāl al-Dīn ibn Muḥammad Muqīm of Lahore … Longitude differences from the central meridian and latitudes in the northern hemisphere are represented by their sines on the horizontal and vertical axes, and there is an annulus of grid markings around the map but none on the map itself. Mecca is neither at the centre nor on the central meridian, and the qiblas of various localities that are represented by

rectilinear segments joining them to Mecca are based on another approximation, namely $q = \tan^{-1}\{[\sin L - \sin L_M] / [\sin \varphi - \sin \varphi_M]\}$.[520]

Along the vertical diameter of the mater which divides the two halves is drawn a scale; it is labelled in 6s, from the centre up to the periphery on both directions from 6 to 90. Along the rim of the mater, there is a circular scale which is divided in groups of 6° and labelled from the south point onwards from 6 to 90 and once again from 6 to 90. On this grid, several localities are marked with dots enclosed in circles. Lines are drawn from these circles up to the position of Mecca, with labels stating *khaṭṭ samt qibla* … (line of the azimuth of *qibla* from X). The holy city of Mecca is not at the centre of the map, but towards the right. Its position is marked by a large double circle with the label *Makka Muᶜaẓẓam.* We list below the localities and the labels, starting from the left.

Table A121-4 Qibla Map

	Place Name with the Label	Vertical Scale	Circular Scale
1	*khaṭṭ samt qibla Bījāpūr*	30	30
2	*samt qibla Akbarābād*	30	30
3	*samt qibla [Shāh]jahānābād*	28	30
4	*samt qibla Dawlatābād*	24	21
5	*samt qibla Lāhūr*	24	20

520 King 1999b, p. 95; see also Christie's Catalogue, p. 95: David King … writes '[the right] half of the mater is engraved with what is essentially a map. Some 17 localities are marked by means of small circles in the appropriate positions with respect to Mecca. The horizontal diameter of the mater is taken as the equator, and the longitudes from 0° to 180° are measured along this diameter from left to right. The city of Mecca, the physical focus of Muslim worship, is clearly marked and lines are drawn representing the *qiblas* of various localities. For the region of the maker, the towns of Lahore, Akbarābād, Jihānābād and Kabul are represented. Such cartographic procedures for finding the *qibla* were already advocated in the ninth century, but diagrams are rare. Indeed, two are known from manuscript sources, and instruments engraved with such diagrams are also uncommon.' See also King 1992a; King & Lorch 1992.

	Place Name with the Label	Vertical Scale	Circular Scale
6	(No label)	18	18
7	*khaṭṭ Banāras*	18	16
8	*samt qibla Kābul*	18	15
9	*khaṭṭ samt qibla Burhānpūr*	18	14
10	*samt qibla Mashhad*	6	3
	khatt nahār meridian ?		
11	*khaṭṭ Iṣfahān*	12	87
12	*khaṭṭ Bazal* ?	12	84
13	*Makka Muʿaẓẓam*	18	78
14	*samt qibla Madīna Ṣabab*?	18	46
15	*samt qibla Bayt al-Maqdis*	24	36
16	*samt qibla Jazīra Jānz*	44	48
17	*Jazīra* *** (no point)		

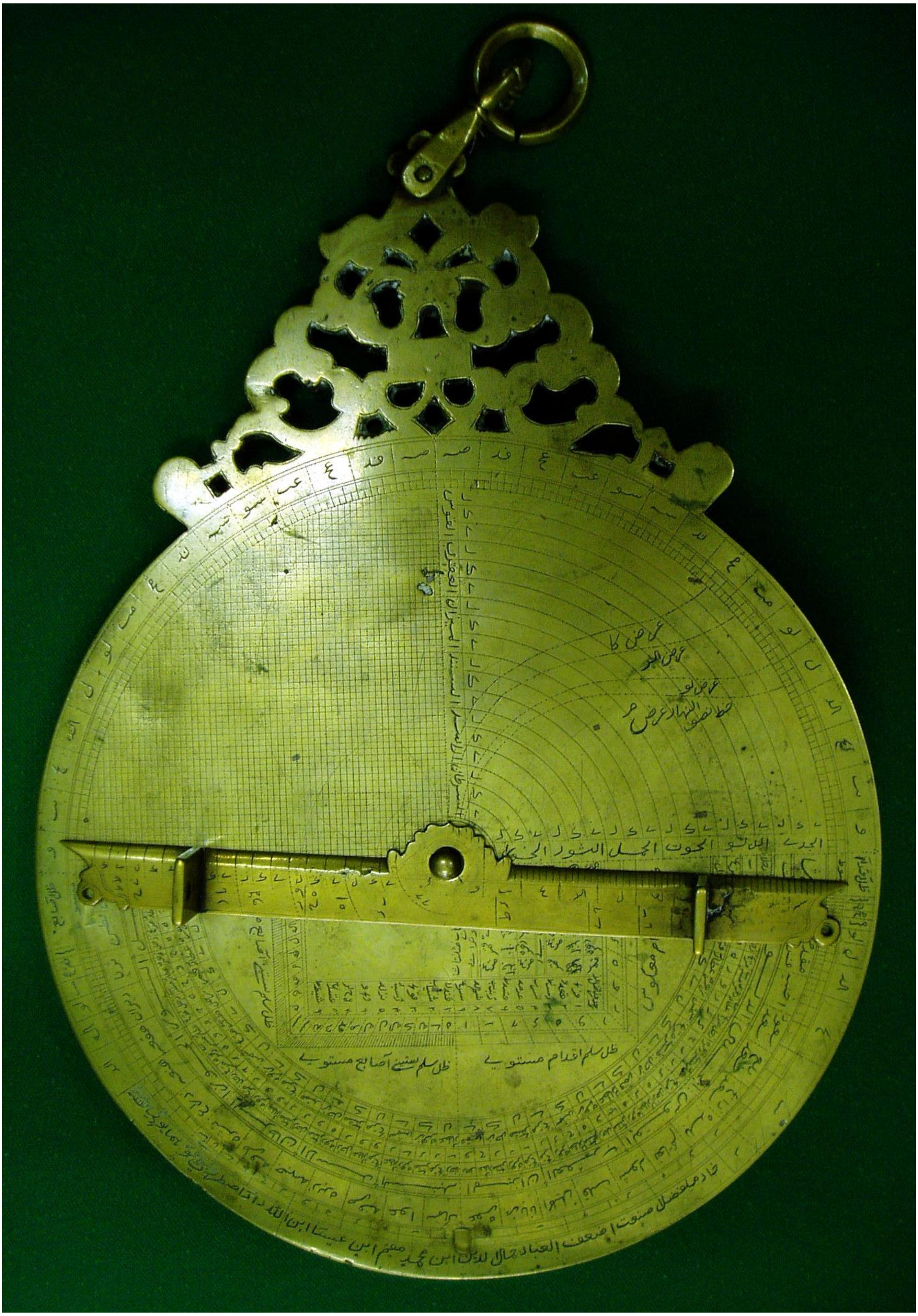

Figure A121.6 – Back of the Astrolabe (photo by S. R. Sarma)

BACK

The altitude scales on the upper half of the rim are graduated in 1°, 2° and 6° and numbered in 6s as 6---90; 90---6. In the upper left is the trigonometric quadrant with 60 horizontal and 60 vertical parallels of which every sixth line is highlighted with dots. Semi-circles are drawn on the vertical and horizontal radii and quarter circles at 8, 10½, 12, 24 units.

In the upper right is the solar quadrant with declination arcs at intervals of 10° of solar longitude. The names of the corresponding signs and their divisions of 10°, 20°, 30° are written along the two radii. On this quadrant are plotted four curves of the meridian altitude of the sun at latitudes 21°, 27°, 36°, 40°; the last curve is accompanied by the full label *khaṭṭ niṣf al-nahār bi-ᶜarḍ 40.* Under the other curves are written just the latitude values.

In the lower half are the double shadow squares, on the left for a gnomon of 12 digits and on the right for a gnomon of 6 feet. The vertical and horizontal scales on the left are divided into 12 parts and each part into 5 units. These are numbered in 5s from 5 to 60. The vertical scale bears the label *ẓill sullam sattaynī āṣābiᶜ maᶜkūs* and the horizontal scale *ẓill sullam sattaynī āṣābiᶜ mustawī.* The horizontal and vertical scales on the right are divided in 7 parts and numbered from 1 to 7; they bear the labels *ẓill sullam aqdām mustawī* and *ẓill sullam aqdām maᶜkūs* respectively.

Inside the shadow squares are the tables of excess of revolution (*faḍl al-dawr*) and of triplicities.

The lower half is framed by cotangent scales and their subdivisions which are engraved on the rim; the one on the left carries the label *ẓill āṣābiᶜ* and that on the right *ẓill aqdām.*

Inside the cotangent scales, there are 6 semi-circular rows. The first two are engraved with the names of the 28 lunar mansions and the 12 zodiac signs; the next two rows contain the table of limits (*al-ḥudūd*) and the last two the table of faces (*al-wujūh*).

Figure A121.7

ALIDADE ETC

The alidade has ornate ends and an ornate centre-piece. The right half carries a sexagesimal scale numbered in 6s from 6 to 60. The left half is engraved with declination arcs and marked with the serial numbers of the signs and their subdivisions of 10°, 20° and 30°. The lower register on the right bears markings of unequal hours when the alidade is used as a sundial with the sighting plate on the right as the gnomon.

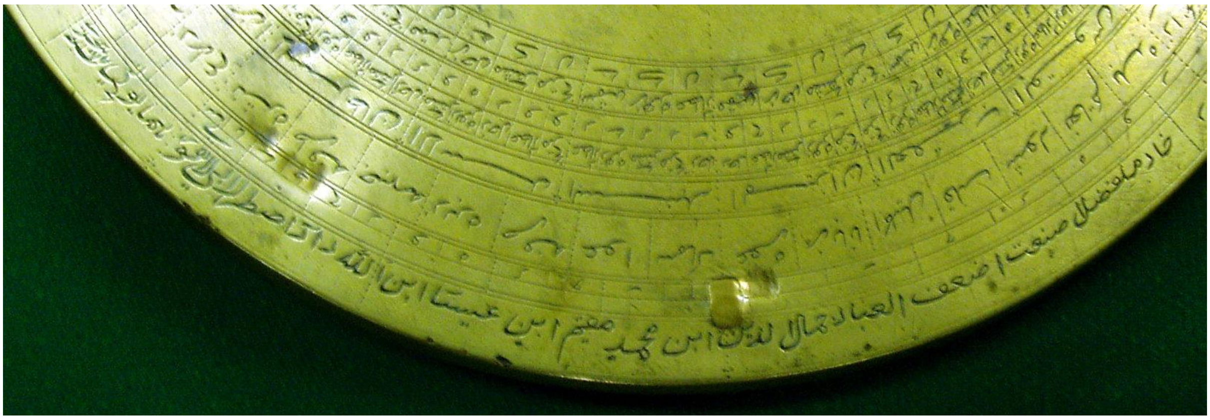

Figure A121.8

INSCRIPTION

The maker's name is engraved on the lower rim in the middle of the cotangent scales and reads as follows:

> *khādim al-fuḍalā' ṣana^{c}t aḍa^{c}f al-^{c}ibād jamāl al-dīn ibn muḥammad muqīm ibn ^{c}īsā ibn allāhdād asṭurlābī lāhūrī humāyūnī sanah 1077 hijrī.*
>
> 'The servant of the eminent, the weakest of the servants [of God], Jamāl al-Dīn, son of Muḥammad Muqīm, son of ^{c}Īsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, made [this astrolabe in] the year 1077 Hijrī (= AD 1666-67).'

PROVENANCE

Formerly in the collection of David H. H. Felix, Philadelphia.

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King 1992a, I, pp. pp.167-171.

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A122⊙ ASTROLABE BY JAMĀL AL-DĪN, 1092 AH (AD 1681-82)

Diameter 166 mm

London, Victoria & Albert Museum (30-1882 (I.S)[521]

CCA 81; Répertoire 2

In this astrolabe, the alidade is mounted on the front and all the components are joined with a nut and bolt and welded. Consequently, the bolt cannot be unscrewed to open the astrolabe and to examine the plates and the gazetteer.

A geographical gazetteer is engraved on the edge of the astrolabe. At the apex of the *kursī* are engraved the arguments, *al-bilād, al-ṭūl* and *al-arḍ* on both sides, followed by the names of towns, their longitudes and latitudes. Much of this gazetteer is difficult to decipher. Therefore it has not been copied.

COMPONENTS

Body with *kursī* (d. 166, h. 225, t. 7), shackle and ring, rete for 45 stars, ? plates, alidade; the pin and horse are missing.

FRONT

The *kursī* has a very wide base. Its contours are formed by ogees and lobes; the finial is not trifoliate, but with five lobes. The *kursī* is pierced symmetrically, producing in the middle a crude cartouche on which is engraved *Allāhu Akbar* on the front. On the surface in the front decorative lines are drawn parallel to the pierced holes.

The limb is graduated in 1°, 2° and 6° and labelled in 6s from 6° to 90°, separately for each quadrant.

RETE

The rete is very dark and coppery. The equinoctial bar has counter changes at its two intersections with the ecliptic. The solstitial bar is complete, but blended with the tracery that joins the various star pointers. The ecliptic band is rather broad; it is divided into the 12 signs of the zodiac and labelled with their names. Each sign is further subdivided into 6° each which are numbered in *abjad* symbols from 6 to 30, separately

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[521] Victoria and Albert Museum wrote to me to say that they do not permit publication of private photography of their objects. Therefore, this entry is regretfully without my photos.

for each sign. The sloping edge of the zodiac ring is divided into 3°. The star pointers and the tracery that joins them are indifferently designed with hardly any trace of elegant designs made by the astrolabe maker's father Muqīm or the cousin Ḍiyā' al-Dīn. The tracery looks more like the traceries of his brother Ḥāmid.

There are said to be 45 star pointers, some of which are blocked by the alidade. The following 39 could be deciphered.

Table A122-1 Stars on the Rete

	Star Name	Identification
1	*Dhanab al-Qayṭus J[anūbī]*	β Ceti
2	*Rijl al-Musalsala*	γ Andromedae
3	*Fam al-Qayṭus*	γ Ceti
4	*Ṣadr al-Qayṭus*	π Ceti
5	*Ghūl*	β Persei
6	*Kaff al-Jadhmā'*	α Ceti
7	*Mirfaq al-Thurayyā*	α Persei
8	*Tālī Masāfat al-Nahr*	γ Eridani
9	*ᶜAyn al-Thawr*	α Tauri
10	*ᶜAyyūq*	α Aurigae
11	*Yad al-Jawzā' al-Yumnā* ?	α Orionis
12	*Rijl al-Jawzā' al-Yumnā*	κ Orionis
13	*Shiᶜrā Yamānī*	α Canis Majoris
14	*Shiᶜrā Shāmī*	α Canis Minoris
15	*Ṭaraf Safīna*	ρ Puppis
16	*Minkhar al-Shujāᶜ*	σ Hydrae
17	*Qalb al-Asad*	α Leonis
18	*Qāᶜidat al-Bāṭiya*	α Crateris

	Star Name	Identification
19	*Ṣarfa*	β Leonis
20	*ᶜAnāq*	ζ Ursae Majoris
21	*Janāḥ al-Ghurāb*	γ Corvi
22	*Simāk Aᶜzal*	α Virginis
23	*Simāk Rāmiḥ*	α Bootis
24	*Nayyir Fakka*	α Coronae Borealis
25	*ᶜUnuq al-Ḥayya*	α Serpentis
26	*Rukbat al-Ḥawwā* ?	ζ Ophiuchi
27	*Rās al-Jāthī*	α Herculis
28	*Rās al-Ḥawwā'*	α Ophiuchi
29	*Yad Yumnā al-Muqaddam*	δ Ophiuchi
30	*Nasr Wāqīᶜ*	α Lyrae
31	*Minqār al-Dajāja*	β Cygni
32	*Nasr Ṭā'ir*	α Aquilae
33	*Dhanab al-Dulfīn*	ε Delphini
34	*Dhanab al-Dajāja*	α Cygni
35	*Fam al-Faras*	ε Pegasi
36	*Dhanab al-Jadī*	δ Capricorni
37	*Sāq Sākib al-Mā' Janūbī*	δ Aquarii
38	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
39	*Mankib al-Faras*	β Pegasi

PLATES

Since the astrolabe cannot be taken apart, the number and other details of the plates cannot be ascertained. Through the interstices of the rete can be seen the topmost plate on which the latitude is engraved as 27° and the duration of the longest day is given as 13 hours; almucantars are drawn for every 3° and azimuths for every 10° below the horizon.

GEOGRAPHICAL GAZETTEER

It is not known whether a gazetteer was engraved on the inner side of the mater. There is one on the edge of the mater, but it is largely undecipherable.

BACK

The rim of the upper half is divided, as in the front, into 1°, 2°, and 6° and labelled as 6—90.90—6. The upper left quadrant is filled with 60 horizontal and 60 vertical parallels; attempt was made to emphasis ever fifth line with dots, but this has not been carried out uniformly. Semi-circles are engraved on both the radii and 3 quarter circles around the centre at 24 units (the arc of the obliquity of the ecliptic), 12 units (?) and 8 units (?). There is a line joining the centre to 45° on the arc and another line joining the inner terminals of the arc.

The upper right quadrant is divided by 18 concentric declination arcs, one for each decan. Every third curve, being the boundary between two signs, is dotted. The names of the related signs and the numerical values of the decans are inscribed along the two radii. Upon these declination arcs are superimposed four curves of solar meridian altitude for the following four latitudes: *ᶜarḍ 27; 29; ᶜarḍ 32,* and *khaṭṭ niṣf al-nahār ᶜarḍ 36*. The first three are the latitudes Agra, Delhi and Lahore respectively. The fourth latitude of 36° represents the middle of the fourth of the seven climates of antiquity and thus the middle of the inhabited world.

In the lower half are drawn two shadows squares, on the left for a base of 6 and 12 and on the right for 7, with the usual division of the respective scales and with the usual labels. Inside the shadow squares is engraved the astrolabe maker's signature which is reproduced below.

The broad rim on the lower half carries the cotangent scales in three concentric bands. The outer band is divided in unequal divisions. Those on the left are numbered,

starting from the vertical diameter, as 6, 12, 18, 24, 30, 36, 42, 48, 54, 60, followed by the words *ẓill aṣābic mustawī*; those on the right are numbered 6, 4 (?), 12, 18, 24, 30, 36, 42, 48, 54, 60 followed by the words *ẓill aqdām mustawī*. In the middle band the units of the outer band are divided into 6 parts each and the first 12 divisions are numbered on both the sides. In the inner band, some of the units on the middle band are halved but not all.

In the space between the cotangent scales on the rim and the shadow squares are drawn six semi-circular rows. Starting from the outside, these contain the names of the 28 lunar mansions, the names of the 12 signs of the zodiac, the table of limits and the table of faces.

ALIDADE

The alidade is graduated with the declination arcs and the names of pairs of signs on the right hand side and with a sexagesimal scale and a scale of unequal hours on the left. There are three holes of different magnitudes in the two sights.

INSCRIPTION

Engraved inside the shadow square:

khādim al-fuḍalā' aḍcaf al-cibād jamāl al-dīn
ibn muḥammad muqīm ibn cīsā ibn allāhdād asṭurlābī
humāyūnī lāhūrī sanah 1092 hijrī.

'The servant of the eminent, the weakest of the servants [of God], Jamāl al-Dīn, son of Muḥammad Muqīm, son of cĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, [made] [in] the year 1092 Hijrī (= AD 1681-82).'

BIBLIOGRAPHY

Gunther 1932, no. 81, p. 213 (just a short entry of 6 lines).

A123 ASTROLABE BY JAMĀL AL-DĪN, 1094 AH (AD 1682-83)[522]

Diameter 160 mm

Kuwait, PC; ex-collection Alain Brieux

Répertoire 3

Not much information is available on this and the next astrolabe except the short entries in the Répertoire. It is said that in the rete of these two astrolabes there are *zawraqī* arcs designed for a southern astrolabe. On one of the plates of this astrolabe, names of 21 stars are engraved. Unless images of the rete and the plate with the 21 stars are available, it is difficult to visualize how they would have functioned.

RETE

The zodiac ring carries the names of the 12 signs; 42 star pointers; 'line of horizon for a southern astrolabe in contradistinction to A121 where the horizon is northern.'

PLATES

Five plates, including one on which the names of 21 stars are engraved.

BACK

Altitude scales on the upper half of the rim divided in 2°; trigonometric quadrant in the upper left; in the upper right declination arcs and curves for the meridian altitude of the sun at latitudes 32° and 34°. Lower half: shadow squares with a table of triplicities, other astrological tables; cotangent scales on the rim.

INSCRIPTIONS

There are two inscriptions. The first provides the name of the astrolabe maker. The second inscription which is rather long, speaks of the endowment in AH 1094 (AD 1682-83) of a *waqf* and refers to a patron ᶜAbd al-Ghafūr ibn Zayn al-Dīn, the astronomer al-Lārī. It is not known where exactly these inscriptions, especially the very long second inscription, are engraved. The first inscription is reproduced below; the second may be seen in the Répertoire

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522 Entry based on Répertoire 3.

khādim al-fuḍalā' ṣana^ct aḍa^cf al-^cibād jamāl al-dīn ibn muḥammad muqīm ibn ^cīsā ibn allāhdād aṣṭurlābī lāhūrī humāyūnī.

'The servant of the eminent, the weakest of the servants [of God], Jamāl al-Dīn, son of Muḥammad Muqīm, son of ^cĪsā, son of Allāhdād of Lahore, the astrolabe maker to [the emperor] Humāyūn, made [this astrolabe].'

A124 ASTROLABE BY JAMĀL AL-DĪN, 1103 AH (AD 1691-92)[523]

Diameter 254 mm

Istanbul, Türk ve Islam Eserlieri Müzesi (T 3478)

Répertoire 4

Rete

The zodiac ring carries the names of the 12 signs; 56 named star-pointers; line of the southern horizon.

Plates

Seven plates including two which are blank.

Geographical Gazetteer

With place names, longitudes and latitudes.

Back

Altitude scales divided in 2°. Upper left quadrant with graphs of sines, cosines and versed sines; upper right quadrant with curves of the midday altitude of the sun for ?.

Lower half: shadow squares with the table of triplicities, other astrological tables and cotangent scales on the rim.

Inscription

> 'The accomplishment of this astrolabe, which was commanded by the model of the trustees and the example of nobility,
> the pupil of the eye of the authority, and the eye of the man of happiness, Sharaf al-Dīn Ḥasan ibn
> Marjūsh al-Ḥusaynī, by the hand of the servant of eminent men, Mullā Jamāl al-Dīn ibn Muḥmammad Muqīm ibn
> ᶜĪsā ibn Allāhdād of Lahore, the astrolabe maker to [the Emperor] Humāyūn, has taken place in the year one hundred-and-three after one thousand.'

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[523] Entry based on Répertoire 4.

A125 UNIVERSAL ASTROLABE ATTRIBUTABLE TO JAMĀL AL-DĪN[524]

Not dated, 17th century

Diameter 187 mm

London, Ahuan Gallery

Figure A125.1 – Front of the astrolabe (© Christie's, London)

This is a rare *shakkāziyya* type of universal astrolabe designed originally by ᶜAlī ibn Khalaf al-Ṣaydalanī in the elenventh century in Andalusia.[525] The best specimen which follows this design was constructed by Ibn al-Sarrāj in Aleppo in 729 AH (1328-29 AD). It is now preserved in the Benaki Museum at Athens. David King published a description of this specimen.[526] He declares that '[t]his is without doubt the most sophisticated astronomical instrument surviving from the Middle Ages and probably the most sophisticated ever made between Antiquity and 1600.' He goes on to say that this instrument can be universally in five different ways.[527]

The present astrolabe closely resembles ibn al-Sirrāj's specimen. At some stage the two principal parts of the present astrolabe got separated. The rete came up for

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524 Entry based on King 2005, pp. 821-829: 'A universal Astrolabe attributable to Jamāl al-Dīn, a craftsman of 17th-century Lahore'.

525 Cf. Calvo & Puig 2006.

526 King 2005, pp. 694-700.

527 King 2005, p. 694.

auction at Christie's on 4 October 1995 and the mater on 5 April 2001. David King, who wrote the descriptions of these two parts for the Christie's catalogue, realized, when he saw the mater, that these two parts belonged together. Fortuitously the two parts were acquired and put together by the Ahuan Gallery, London.

There is no signature or date on this astrolabe. On calligraphic and stylistic grounds, King attributes it to the Lahore family and, in particular, to Jamāl al-Dīn. He goes on to say that 'Jamāl al-Dīn is known by two astrolabes, of which one, dated 1077 H (=1666/7), is the only known Islamic astrolabe bearing a world-map engraved in the mater. The association with Jamāl al-Dīn is strengthened by the fact that on the new rete the star-name *fakka* is incorrectly written as *falakka,* a mistake also found on the rete of the above-mentioned 1666 instrument.'[528]

But there are some problems with this attribution. The Lahore astrolabes invariably have the trigonometric quadrant in the upper left on the back and the solar quadrant in the upper right. In this astrolabe, this arrangement is reversed. About the trigonometric quadrant, King observes as follows: 'In the upper right, the scale has been labelled the wrong way round, but the maker has added the correct labelling in a smaller script. Such corrections of engraving are extremely rare on Islamic instruments, as are, also, however, mistakes in engraving.'[529] I do not think that numbering in both directions is by mistake, but a deliberate attempt to imitate the practice on the sine quadrants. Such numbering in both directions occurs also in Ḍiyā'al-Dīn's astrolabe of 1656 (A071). However, the numbering on the limb in front where the tops of the letters are towards the centre, is unusual for Lahore astrolabes. Other differences are that in Lahore astrolabes, the finial of the *kursī* is usually trifoliate and the shackle also has a trifoliate shape. These two features are absent in the present astrolabe.

Nevertheless, until evidence to the contrary turns up, we shall follow King's attribution of this astrolabe to Jamāl al-Dīn. King adds that, although this astrolabe closely resembles the Athens astrolabe of Ibn al-Sirrāj, the rete is not an exact copy, because it contains a quatrefoil and a double zodiac scale on the horizontal diameter,

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528 King 2005, pp. pp. 821-829, esp. 829.

529 King 2005, p. 824.

features which are absent in the Athens specimen. Therefore, postulates King, '[i]t is reasonable to suppose that this newly-identified rete was copied from one by Ibn al-Sarrāj, otherwise unknown to us, which also featured a quatrefoil.'[530]

COMPONENTS

Mater with throne (d. 187, t. 5), shackle and ring and rete (d. 168). Alidade, rule, pin and horse appear to have been added later.

FRONT

The *kursī* is solid and plain with lobed profiles; the finial is not trifoliate. The shackle does not have the trifoliate shape either. The bases of the shackle are shaped like flowers. A ring with a square cross-section passes through the shackle. On the front of the *kursī* is engraved *Jamshed,* apparently a late addition by an owner.

The limb is divided in 1° and 6° and numbered clockwise in 6s from 6 to 360. The numbers are engraved upside down, i.e., with their tops towards the centre.

On the inner side of the mater is engraved with *shakkāziyya* universal projection and the markings are inlaid with silver. Meridians are drawn for each 6° and marked on the horizontal diameter (6 to 180 from the left to the right, and again 180 to 360 from the right to the left). Declination circles also are drawn for every 6° and the arguments are marked on the vertical diameter (6 to 90) from the centre both up and down.

RETE

The rete has the *shakkāziyya* markings in the upper half and astrolabe markings in the lower half. In the upper half, meridians and declination circles for each 6° are cut very carefully and accurately and the arguments are engraved on the horizontal diameter and on the circumference. Signs of the ecliptic are also engraved on the horizontal bar in two rows, starting from the centre and proceeding left up to the periphery, then from there up to the right periphery, and from there up to the centre.

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530 King 2005, p. 829.

The lower half displays an arc of the ecliptic and star pointers. On the arc of the ecliptic, the southern signs are superimposed on the northern signs, starting with Aries and Libra at the left. The signs are divided in 6° and labelled.

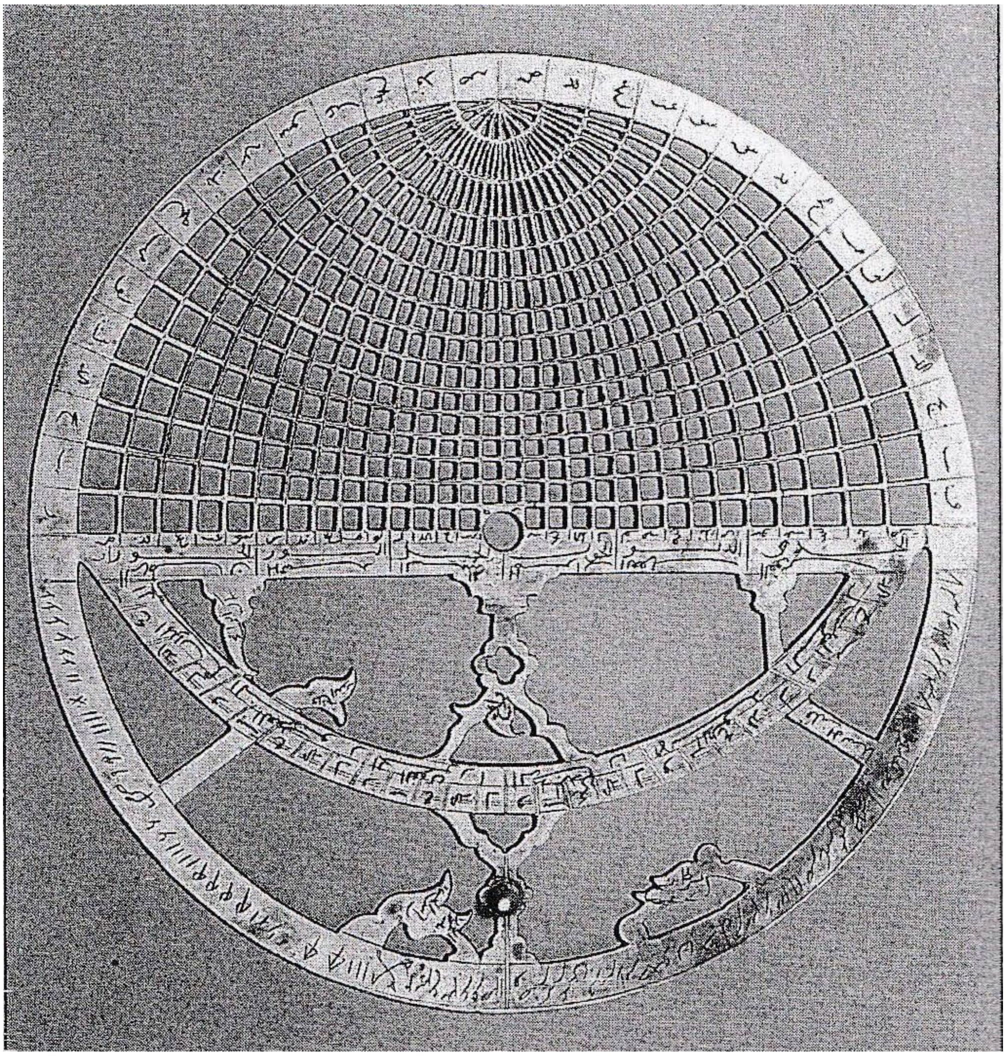

Figure A125.2 – The rete (photo from Sotheby's catalogue of 4 October 1995)

The star pointers serve the following 11 stars (04 and 11 are not named):

Table A125-1 Stars on the Rete

	Star Name	Identification
1	*Simāk al-Rāmiḥ*	α Bootis
2	*Al-Ghūl*	β Persei
3	[*Fakka*] written *Falakka*	α Coronae Borealis
4	[*al-ᶜAyyūq*]	α Aurigae

	Star Name	Identification
5	*Rās al-Ḥawwā’*	α Ophiuchi
6	*Yad al-Jawjā’*	α Orionis
7	*Wāqi*ᶜ	α Lyrae
8	*Ghumasyā’*	α Canis Minoris
9	*Nasr al-Ṭā’ir*	α Aquilae
10	*Qalb al-Asad*	α Leonis
11	[*Fam al-Hūt* (?)]	α Piscis Austrini

King notes that ‘[t]he positions of all but the last star-pointers are extremely accurate for *ca.* 1650. The penultimate pointer, named *Qalb al-Asad,* bears no marker for the star, but the place where its left-hand edge meets the ecliptic is indeed the position of α Leonis (Regulus) for *ca.* 1650.’[531]

The lower half of the circular frame bore originally no markings. This space has been filled by a latter hand with some irrelevant inscriptions.

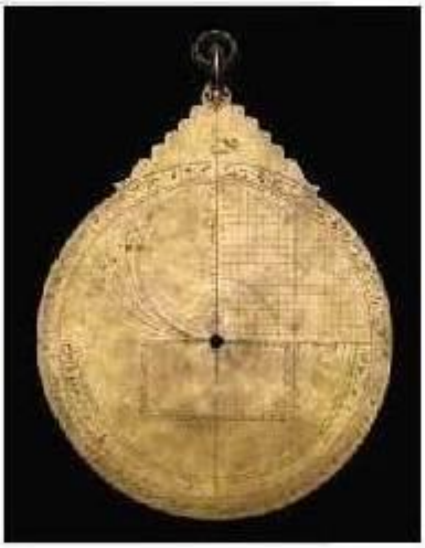

Figure A125.3 – Back of the astrolabe (© Christie’s, London)

[531] King 2005, p. 8

BACK

The rim on the back carries a degree scale which is divided in 1° and 6°. It is numbered in 6°, from 6 to 90, separately in each quadrant. The numbering commences at the east and west points and reaches up to the south and north points. Inside the degree scale, a universal horary quadrant is engraved on the upper left with 6 curves for seasonal hours marked 11/2, 10/3 … 7/5, 6/6. There are no declination arcs in this quadrant. It is framed by the altitude scale which is divided in 1° and 6° and numbered in 6° from 6 to 90, starting from the east point and reaching up to the south point.

A sexagesimal trigonometric quadrant is placed in the upper right, with 20 horizontal and 20 vertical parallels, one for each 3 units of the 60-unit scales. The arguments are engraved on the two radii. A semi-circle is drawn on the horizontal radius for determining the sine and cosine and a quarter circle is drawn with a radius of 24 units for determining the solar declination. The arc framing this quadrant is marked with a degree scale, which is divided in 1° and 6° and numbered in 6s in both directions as is done on solitary sine quadrants.

In the lower half are shadow squares, on the left for a base of 12 and on the right for the base of 7, but without any labels. Inside the degree scales in the lower half are added two cotangent scales; the left one carries the label *ẓill aṣābiᶜ* and the scale on the right the label *ẓill aqdām.*

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Christie's, catalogue of 5 April 2001, lot 32, http://www.christies.com/lotfinder/LotDetailsPrintable.aspx?intObjectID=2021394 [also http://goo.gl/kgQYiR, last accessed in May 2016]

King 2005, pp. 821-829: 'A universal astrolabe attributable to Jamal al-Din, a craftsman of 17th-century Lahore'.

Calvo & Puig 2006.

A126 ASTROLABE ATTRIBUTABLE TO JAMĀL AL-DĪN[532]

Not dated, 17th century

Diameter 96 mm

PLU; ex-London, Sotheby's

Figure A126.1 – Front of the astrolabe (photo from Sotheby's catalogue of 5 May 1989)

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532 Entry based on photos and photocopies of the plates in the archives of the Museum of the History of Science, Oxford, and Sotheby's auction catalogues of 19 October 1982 and 5 May 1989.

The crown of this unsigned and undated astrolabe is somewhat unusual for a Lahore astrolabe, but on the back there are two curves for the midday altitude of the sun at latitudes 27° (Agra) and 32° (Lahore). The coordinates of the several Indian cities in the gazetteer match with the same in Jamāl al-Dīn's astrolabe of 1666 (A121); in particular, both the gazetteers refer to Delhi as Jahānābād instead of Shāhjahānābad. Therefore, this too may have been made by Jamāl al-Dīn.

COMPONENTS

Body with *kursī* (d. 96), shackle, ring, long cord, rete, 7 plates, alidade. Pin and wedge are missing. The ensemble is held together by a long bolt and winged nut.

FRONT

The shackle with rectangular sides and the very low *kursī* with irregular lobes and four circular perforations are most unusual. The surface of the *kursī* is adorned with floral decorations in low relief on both sides.

The limb is divided in 1° and 6° and numbered clockwise from 6 to 90, in each quadrant separately.

RETE

The peripheral Capricorn ring and the eccentric ecliptic ring are held together by the equinoctial bar which has counter changes at the two equinoxes. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names; each sign is divided into units of 6° and numbered from 6 to 30. There is a handle on the Capricorn ring about 30° south of the west point. The Capricorn index is well defined. The ca. 29 star pointers are joined by an asymmetric tracery.

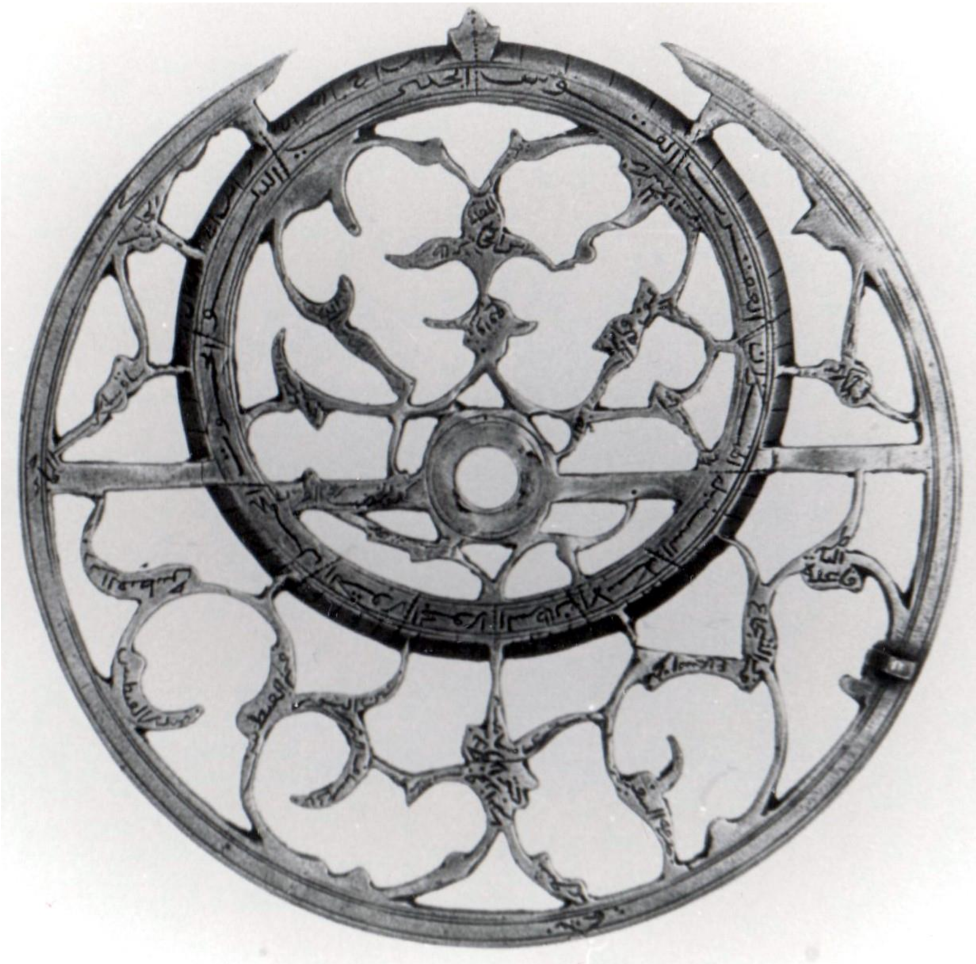

Figure A126.2 – Rete of the astrolabe (photo courtesy Museum of the History of Science, Oxford)

PLATES

There are seven plates. The first four are original and the remaining three with the arguments engraved in large and bold letters belong to some unidentified Persian astrolabe.

Table A126-1 Plates

	φ	Longest Day
1a	22°	12;21 hours
1b	Double projections for 0° + 90°	
2a	25°	13;34 hours
2b	27°	13;58 hours
3a	36°	14;32 hours
3b	40°	14;52 hours

	φ	Longest Day
4a	Tablet of ecliptic coordinates with the label *ṣafīḥat mīzān al-ᶜankabūt.*	
4b	Tablet of horizons *ṣafīḥa āfāqī.*	
5a	30°	13;17 hours
5b	36°	14;18 hours
6a	32°	14;7 hours
6a	Tablet of horizons	
7a	?	?
7b	astrological houses at latitude ?	

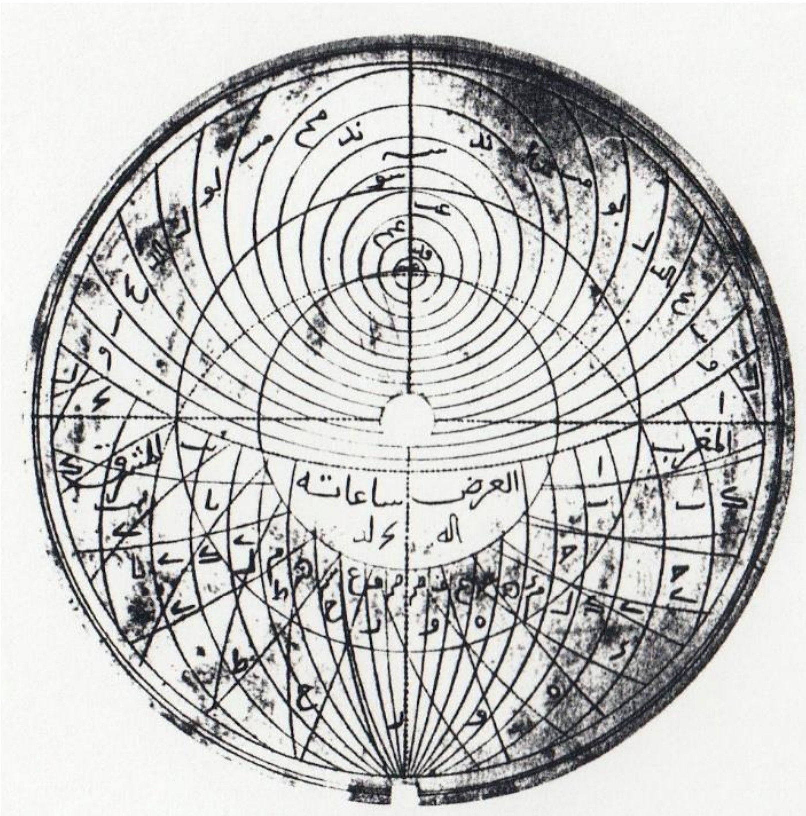

Figure A126.3 – Plate 2a for the latitude 25°
(photo courtesy Museum of the History of Science, Oxford)

On plates 2 and 3, altitude circles are drawn for every 6° and numbered on both sides of the meridian; azimuth arcs are drawn for every 10° below the horizon and numbered below the circle of Cancer. There are lines for seasonal hours and lines drawn

from the western horizon for equal hours. On plate 1a, altitude circles are drawn for 6°, but there are no azimuth arcs. There are lines for seasonal hours and the lines for equal are hours drawn from the western and eastern horizons up to the meridian.

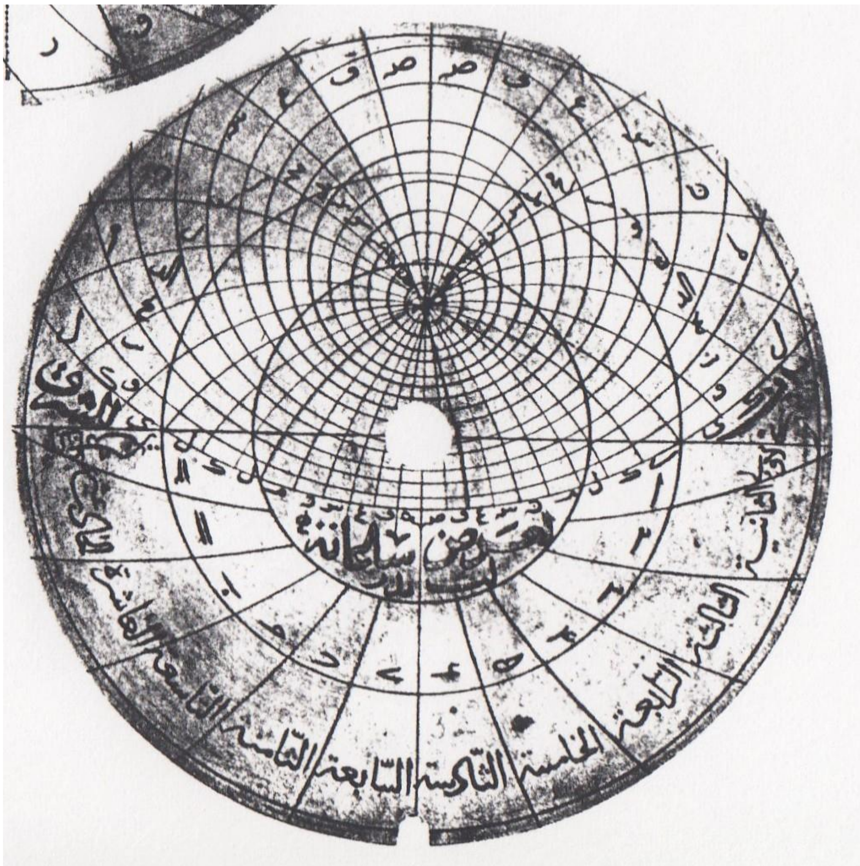

Figure A126.4 – Plate 6a for latitude 32°
(photo courtesy Museum of the History of Science, Oxford)

Plates 5, 6, 7 are quite different. On these the terms *al-ᶜarḍ, sāᶜāt, maghrib* and *mashriq* are engraved in very large and bold letters. On plate 5a and 5b, altitude circles are drawn for every 6° and azimuth arcs for every 10° above the horizon. On 5a, there are only lines for seasonal hours; these are numbered in *abjad* below the equator and in common numerals above the equator. On 5b there are also lines drawn from the western horizon for equal hours.

On 6a for 32°, there are altitude circles for every 6°, azimuth arcs for every 10° above the horizon and lines only for seasonal hours as on 5a. But here the seasonal hours are labelled in ordinal numbers written in ornate letters just above the circle of Capricorn. In Lahore astrolabes, the geographical coordinates and the maximum number of daylight hours given for many localities are not always consistent. However, for Lahore, the latitude is invariably 31;50° and the maximum number of hours 14;8. But here the maximum duration engraved is 14;7 hours, indicating that this plate is not

produced in Lahore. The reverse of the plate is engraved with multiple half-horizons, with bold labels.

On plate 7a the arguments *al-ᶜarḍ* and *al-sāᶜāt* are engraved in bold letters, but the actual values are not filled. The plate appears to be made for 32° with altitude circles for every 6°, azimuth arcs above the horizon for every 10° and just lines for seasonal hours numbered in both Abjad and common numerals.

On plate 7b are drawn astrological houses, each divided into decans marked as 10, 20 and 30 below the circle of equator. The houses are numbered, anti-clockwise from vernal equinox in common numerals below the circle of Cancer and in ordinal numbers (*al-ṭāliᶜ* to *al-thānī ᶜashar*) above the circle of Capricorn.

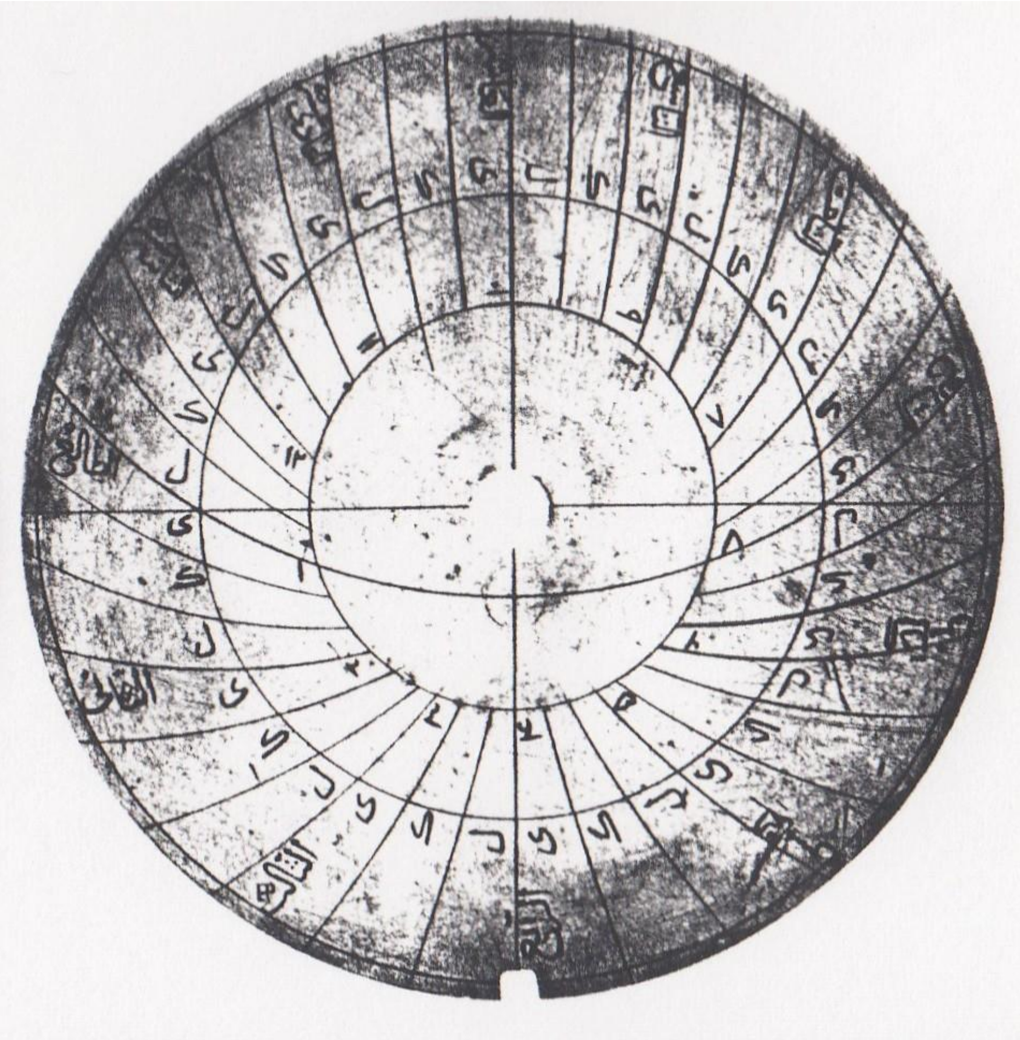

Figure A126.5 – Plate 7b with the astrological houses
(photo courtesy Museum of the History of Science, Oxford)

Figure A126.6 – Geographical gazetteer
(photo courtesy Museum of the History of Science, Oxford)

GEOGRAPHICAL GAZETTEER

The geographical gazetteer provides the names and coordinates of 54 localities in two circles.

Table A126-2 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
1	Makka Mu^{c}aẓẓam	77;10	21;40

	Place Name	L	φ
2	Madīnat Musharrafa	75;20	25;0
3	Ṭāᶜif	72;30	21;20
4	Bayt al-Maqdis	66;30	31;50
5	Qayrawān	41;0	31;0
6	Baghdād	82;0	33;35
7	Tabrīz	82;0	38;0
8	Fīrūzābād	87;30	28;10
9	Shīrāz	88;0	29;36
10	Qazwīn	85;0	36;45
11	Iṣfahān	86;40	32;35
12	Mashhad	92;30	36;0
13	Yazd	89;0	32;0
14	Harat	94;20	34;30
15	Balkh	101;0	36;11
16	Bukhārā	97;30	39;50
17	Samarqand	99;16	39;37
18	Kashghar	106;30	44;0
19	Khutan	107;0	92;0 ! it should read 42;0
20	Hurmūz	92;20	25;0
21	Kirmān	41;30!	30;5 it should read 91;30
22	Ghazna	104;20	33;35
23	Kābul	104;40	34;30
24	Tubbat	110;0	40;0

	Place Name	L	φ
25	Kashmīr	108;0	35;0
26	Qandahār	107;40	33;0
27	Sālkūt	109;0	33;0
28	Multān	107;25	29;40
29	Lāhūr	109;20	31;50
30	Jahānābād	113;0	29;0 for Shāhjahānābād !
31	Akbarābād	115;0	26;43
	Inner Circle		
32	Qannawj	114;50	26;20
33	Banāras	117;20	26;15
34	Burhānpūr	113;0	20;30
35	Bījāpūr	114;20	17;40
36	Ajmīr	111;0	26;0
37	Kūlkanda	114;19	28;4!
38	Sarāndīb	130;0	10;0
39	Kanbayāt	109;20	26;20
40	Aḥmadnakar	115;0	19;0
41	Aḥmadābād	108;40	23;15
42	Jadda	76;0	21;0
43	Ujjayn	110;50	23;30
44	Kawāliyar	114;0	26;39
45	Jamkūt	170;0	5;0
46	Samīr ?	105;40	32;15
47	Khabīr ?	110;0	18;48

	Place Name	L	φ
48	Dawlatābād	111;5	20;30
49	Jawnpūr	119;6	26;36
50	Awadh	118;6	27;32
51	Badāūn	114;15	27;30
52	Pānīpatah	113;20	28;12
53	Tānīsar	112;0	32;15
54	Sunām	112;25	32;30

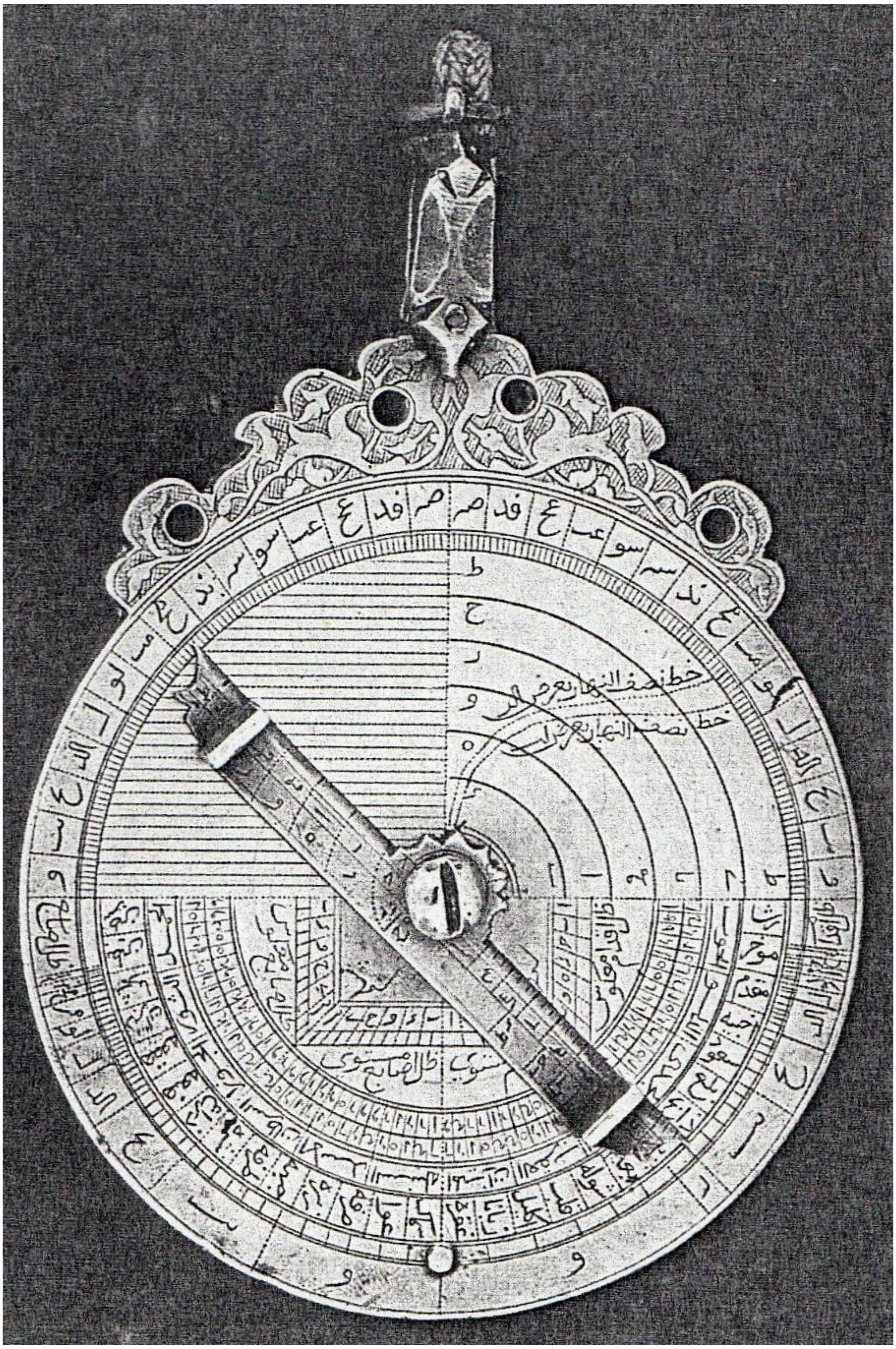

Figure A126.7 – Back of the astrolabe (photo from Sotheby’s catalogue of 5 May 1989)

BACK

On the back, the rim of the upper half is engraved with altitude scales, divided in 1° and 6° and numbered as 6---90; 90---6. In the upper left is the trigonometric quadrant with 30 horizontal parallels, showing cosines for each 2 parts of the 60 parts of the

Radius. In the upper right is the solar quadrant with 6 declination arcs and two graphs for the meridian altitude of the sun at 27° and 32° with the appropriate labels.

There are shadow squares in the lower half; on the left for a base of 12 and on the right for a base of 7.

The rim of the lower half carries cotangent scales and their subdivisions. Between these and the shadow squares, there are four semi-circular rows. Here the first two rows are filled with the names of the 28 lunar mansions and those of the 12 corresponding zodiac signs. The next two rows contain the table of limits.

ALIDADE

The alidade carries declination scales on the left half and linear scales on the right half. In the lower register on the right, there are marks of unequal hours when the alidade is used as a sundial.

PROVENANCE

In the archives of the Museum of the History of Science, Oxford, there are photos of the rete, gazetteer and back of this astrolabe, and photocopies of all components, with a note by Francis Maddison in his characteristic handwriting which says: 'Astrolabe | Indo-Persian | Not Signed | Not Dated. Late 17th century | Brass | Brought to MHS on 14 April 1981 by … f[o]r examination | Neg. ref. no. 81-10abc.35.S.'

The astrolabe came up for auction at Sotheby's on 19 October10.1982 (lot 50) and on 5 May 1989 (lot 213)

ASTROLABES ATTRIBUTABLE TO THE LAHORE WORKSHOP

There are a few Indo-Persian astrolabes which display certain characteristic features of the Lahore astrolabes, but are difficult to be assigned to any individual member of the Lahore family. Some of these may have been commenced by Muqīm or Ḍiyā’ al-Dīn, but completed by the apprentices in the Lahore workshop.

A127$^{\odot}$ ASTROLABE ATTRIBUTABLE TO THE LAHORE WORKSHOP

Not dated, 17th century

Diameter 183 mm

Hyderabad, State Museum of Archaeology (# P720)

Figure A127.1 – Front of the astrolabe (photo by S. R. Sarma)

This is a well-crafted astrolabe; the elegant *kursī* is reminiscent of Muqīm's work and the rete could have been fashioned by Ḍiyā' al-Dīn; the calligraphy and engraving

are of high quality. Curves for the solar meridian altitude at latitudes 27° and 32° are drawn on the back. But there are inconsistencies and gaps which are inexplicable. In the gazetteer, the sequence of the three elements (i.e., place name, longitude and latitude) varies in each of the three circles. In the tablet of ecliptic coordinates, the latitude circles are not numbered. On the back, grids are drawn for astrological tables, but not completely filled in.

COMPONENTS

Body with *kursī* (d. 183, h. 247, t. 9), shackle, rete for 43 stars, 5 plates. Ring, alidade, horse and pin are missing; held together by a bolt and a nut.

FRONT

The shackle is not trifoliate; it is just circular and has a rectangular cross-section. The *kursī* is elegantly reticulated. The profiles are formed by the flared petals of tulips at the base; the finial is trifoliate. The limb is graduated in 1° and in 5° and numbered in 5s from 5 to 360.

RETE

The Capricorn and ecliptic rings are held together by the equinoctial bar which has counter-changes at its two intersections with the ecliptic ring. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names. Each sign is divided in groups of 6° and numbered from 6 to 30. There is a handle near the west point. At the south point of ecliptic is the Capricorn index. The 43 star pointers are joined by an almost symmetric floral tracery.

PLATES

There are 5 plates.

Table A127-1 Plates

	φ	Longest Day
1a	20°	13;34 hours
1b	22°	13 hours !
2a	27°?	---

	φ	Longest Day
2b	32°	14;8 hours
3a	34°	14;22 hours
3b	36°	14;32 hours
4a	38°	14;44 hours
4b	40°	14;54 hours
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

On plates 1 to 4, altitude circles are drawn for every 2° and numbered; every fifth circle is dotted. Azimuth arcs are traced for every 6° below the horizon; every fifth arc is dotted and drawn both below and above the horizon. Plate 4b, however, carries no azimuth arcs. In the lower half, there are plain lines for seasonal hours and dotted lines for equal hours which are drawn from the western horizon.

Plate 5a carries the tablet of ecliptic coordinates. Here latitude circles are traced for every 3°, every fifth dotted. But they are not numbered. Longitude circles are drawn for every 6°, every fifth circle which represents the beginning of a zodiac sign is dotted. The names of the signs are written along the ecliptic together with the values of the longitude circles. There is no label mentioning the name of the plate.

The tablet of horizons carries four sets of half horizons for every degree of latitude from 3° to 66°, spaced at intervals of 4° in the following manner:

3	7	11	…	55	59	63
4	8	12	…	56	60	64
5	9	13	…	57	61	65
6	10	14	…	58	62	66.

The horizon arcs are numbered at both the extremities. There are declination scales along the radii between the equator and the two tropics, divided in 2° and labelled as 6, 12, 18, 23;30, the last value being the obliquity of the ecliptic. There is no label mentioning the name of the plate.

Geographical Gazetteer

The geographical gazetteer, engraved in three circles on the inner surface of the mater, provides the names, longitudes and latitudes of 109 localities. But the sequence of the three elements is not uniform in the three circles.

Outer circle: place name, longitude and latitude

Middle circle: longitude, place name and latitude

Inner circle: Place name, latitude and longitude.

Such inconsistency does not occur in any other astrolabe. In the table below, however, we follow the usual practice of place name, longitude and latitude. The lines separating the cells in the three circles create a spiral formation.

Table A127-2 Geographical Gazetteer

	Place name *(al-bilād)*	**L** *(al-ṭūl)*	**φ** *(al-ᶜarḍ)*
	Outer Circle		
1	Qayrawān	41;0	31;40
2	Mahdiyya	42;15	32;30
3	Miṣr	63;20	30;20
4	ᶜAdan	76;0	11;0
5	Madīnat Tayyiba	75;20	25;0
6	Makka Musharraf	77;10	21;40
7	Ṭā’īf	77;30	21;20
8	Bayt al-Maqdis	66;30	31;50
9	Dimashq	70;0	33;15
10	Ḥalab	72;10	35;30
11	Ardabīl	82;30	38;0
12	Quway	66;30	31;0
13	Raqah	73;55	36;0
14	ᶜĀna	76;30	34;0

	Place name *(al-bilād)*	**L** *(al-ṭūl)*	**φ** *(al-ᶜarḍ)*
15	Mawṣil	75;0	34;30
16	?	75;0	34;30
17	Mūqān	83;0	28;0
18	Bardaᶜa	83;0	40;30
19	Bāb al-Abwāb	85;0	43;0
20	Bulghār	90;0	49;30
21	Kūfa	79;30	31;30
22	Madāīn	72;0	23;10
23	Baghdād	80;0	23;25
24	Baṣra	84;0	30;0
25	Farrūkhābād	87;30	28;10
26	Shīrāz	88;0	29;36
27	Yazd	109;0	32;0
28	Abhar	84;30	36;45
29	Hamadān	83;0	35;10
30	Karaj	84;45	34;0
31	Sāwah	85;0	35;0
32	Qazwīn	80;0	36;0
33	Iṣfahān	86;40	32;35
34	Kāshān	86;0	34;0
35	Qumm	85;40	34;45
36	Rayy	86;20	35;0
37	Ṭāliqān	85;45	36;10
38	Astarābād	89;35	36;50

	Place name *(al-bilād)*	L *(al-ṭūl)*	φ *(al-ᶜarḍ)*
39	Samnān	88;0	36;0
40	Dāmghān	88;15	36.20
41	Bisṭām	89;30	36;10
42	Sabzawār	91;30	36;5
43	Nishābūr	91;30	36;21
44	Mashhad	92;30	36;0
45	Tūn	92;30	34;30
46	Qāīn	93;20	23;40
47	Harāt	94;20	34;30
	Middle Circle		
48	Marw	90;0	37;40
49	Fāriyāb	99;0	36;45
50	Balkh	101;0	36;41
51	Andarāb	103;45	36;0
52	Badakhshān	104;27	34;10
53	Hazār Asb	95;0	41;0
54	Qannawj	105;50	26;35
55	Khabrī ?	95;30	39;0
56	Samarqand	99;16	39;37
57	Khujand	89;35	44;55
58	Kāshghar	106;30	44;0
59	Khutan	105;0	42;0
60	Qarāqūrum	105;0	46;0
61	Hurmūz	92;0	25;0

	Place name *(al-bilād)*	**L** *(al-ṭūl)*	**φ** *(al-ᶜarḍ)*
62	Kirmān	91;30	30;5
63	Ghazna	104;20	23;35 ! (it should be 33;35)
64	Kābul	104;40	35;30
65	Daybul	102;30	25;10
66	Dakar ? (Mansūra al-Sind?)	105;0	27;40
67	Qandahār	105;40	23;0
68	Tubbat	110;0	40;0
69	Kashmīr	108;0	35;0
70	Pīshāwar	105;50	31;0
71	Multān	105;35	29;40
72	Siyālkūt	---	23;0
73	Lāhūr	109;20	31;50
74	Pānīpatah	113;20	28;12
75	Tānīsar	112.23	30;20
76	Sanbhal	115;0	28;28
77	Sunām	112;25	30;30
78	Dihlī	113;35	28;12
79	Akbarābād	115;0	26;43
80	Banāras	117;20	26;35
81	Kawāliyar	114;0	26;29
82	Kūl [wa] Jalālī	114;19	28;4
	Inner Circle		
83	Brūj (Bharuch)	101;5	21;20

	Place name *(al-bilād)*	L *(al-ṭūl)*	φ *(al-ᶜarḍ)*
84	Kālpī	116;45	26;36
85	Hāpanāsar (?)	118;45	32;30
86	Jawnpūr	119;6	26;36
87	Kara wa Mānikpūr	118;10	29;49
88	Badāūn	114;19	27;32
89	Sarwaj (?)	72;40	35;50
90	Ujjayn	110;50	23;30
91	Ajmīr	111;05	26;0
92	Awadh	118;6	27;32
93	Lakhnaū	114;23	26;30
94	Kūpāmāū	106;23	26;45
95	Qarmal (?)	104	12;15
96	Baran	114;0	28;48
97	Nawshahr	78;20	38;10
98	Pakand (?)	90;30	19;44
99	Mandū	101;25	22;15
100	?	103;20	20;30
101	Dawlatābād	101;0	20;30
102	Bījāpūr	105;30	16;20
103	Kulkanda	114;19	18;4
194	Sarandīb	130;0	10;0
195	Kanbāyat	109;4	21;20

Back

The rim of the upper half carries altitude scales which are divided in 1° and 5° and numbered 5—90; 90—5. On the upper left quadrant are engraved 60 horizontal parallels. In the upper right quadrant are drawn declination arcs for each 10°. The names of the related signs and the numbers of their divisions (10, 20, 30) are written along the two radii. Two sigmoid graphs of the solar meridian altitude for latitudes 27 and 32 are superimposed on this quadrant with the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ 32* respectively.

In the lower half are shadow squares, on the left for a base of 12 digits and on the right for a base of 7 feet. The labels of the four scales read as follows:

Vertical scale on the left: *ẓill aṣābiᶜ maᶜkūs*
Horizontal scale on the left: *ẓill aṣābiᶜ mustawī*
Horizontal scale of the right: *ẓill aqdām mustawī*
Vertical scale on the right: *ẓill aqdām maᶜkūs.*

Grids are drawn inside the shadow squares for two rectangular tables; apparently for the table of excess of revolution on the left and for the table of triplicities on the right, but these are not filled in.

The shadow squares are enclosed by eight semi-circular rows; each two are separated by double semi-circular lines. Starting from the outside, rows 1 and 2 are marked for cotangents and their subdivisions, but row 1 is not filled in with numbers; only the last cell on the left is engraved with *ẓill aṣābiᶜ* and the last cell on the right with *ẓill aqdām.*

Rows 3 and 4 carry the names of the 12 signs of the zodiac and the names of the 28 corresponding lunar mansions.

Figure A127.2 – Back of the astrolabe (photo by S. R. Sarma)

Rows 5 and 6 are to bear the table of the limits. In row 5 are engraved the names of the planetary lords of the five limits of each sign, but the row 6 is blank.

Rows 7 and 8 are drawn for the table of decans. In row 8 are written the values of decans (10, 20, 30) for each sign; but the names of their regents are not engraved in row 7.

In is inexplicable why these astrological tables were not completed in the otherwise well-crafted astrolabe.

A128 ASTROLABE ATTRIBUTABLE TO THE LAHORE WORKSHOP[533]

Not dated, 17th century

Diameter 153 mm

Washington, D.C., National Museum of American History (#2569)

Figure A128.1 – Front view of the astrolabe
(photo from the archives of the Museum of the History of Science, Oxford)

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533 Entry based of Gibbs & Saliba 1984, no. 2569, pp. 165-169. The star names and the geographical gazetteer are deciphered and added by me.

This unsigned and undated astrolabe is clearly made by some member of the Lahore family. The *kursī,* elegantly reticulated with three large apertures, indicates the work of Muqīm, so also the two graphs of the solar meridian altitude for 27° and 32°. But the zero symbol in the gazetteer which resembles a small pair of scissors is characteristic of Ḍiyā’ al-Dīn. The zigzag pattern of the gazetteer is also indicative of Ḍiyā’ al-Dīn. But there Delhi (no. 36) is referred to as Jahānābād and not Shāhjahānābād. It is Jamāl al-Dīn who, for inexplicable reason, lists Delhi as Jahānābād in his astrolabes A121 and A126. Did he then engrave the gazetteer in the present astrolabe? Interestingly, there are two retes.

COMPONENTS

Body with *kursī* (d. 153), shackle, ring, chain, rete for 43 stars, 5 plates, alidade, pin and horse. Shackle, ring and chain may not be original.

FRONT

The ring and shackle have a diamond cross-section. The shackle is not trifoliate; may be a replacement. The *kursī* is high but narrow, pierced with just three large holes, one oval, two others paisley-shaped, placed slightly below it symmetrically; the finial cannot be seen in the photo, probably trifoliate. The surface is decorated on both sides with embossed vines, leaves and flowers on a hatched background.

The degree scale on the limb is divided in 1°, 2°, 6° and labelled in 6s from 6 to 90, in each quadrant separately, all in clockwise direction.

RETE I

The astrolabe is equipped with two retes, one larger and the other smaller. The larger one is of the standard type. Here the slender Capricorn ring and the wider ecliptic ring are held together by the equinoctial bar which has counter changes at its two intersections with the ecliptic ring. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names. Each sign is subdivided into units of 6° and labelled accordingly from 6 to 30. The edge of the ecliptic ring is divided in 2°.

There are 43 named star pointers which are joined by a floral tracery. Part of it appears to be broken off in the lower right. The positions of the stars are indicated by thick dots. Often these dots are not at the tips of the pointers as they should be, but in the middle of broader bands or rings. Since these star pointers are not thus properly

defined, it would be difficult to align them with the appropriate altitude circle. Star no. 7 is mislabeled.

Figure A128.2 – Rete of the astrolabe
(© National Museum of American History, Washington, D.C.)

Table A128-1 Stars on the Rete I

	Star Name	Identification
1	*Dhanab al-Qayṭus Sh[amālī]*	ι Ceti
2	*Dhanal al-Qayṭus J[anūbī]*	β Ceti
3	*Baṭn al-Ḥūt*	β Andromedae

	Star Name	Identification
4	*[Rijl al-] Musalsala*	γ Andromedae
5	*Fam al-Qayṭus*	γ Ceti
6	*Ṣadr al-Qayṭus*	π Ceti
7	*Kaff al-Khaḍīb* !	β Cassiopeiae
8	*Al-Ghūl*	β Persei
9	*Mirfaq Thurayyā*	α Persei
10	*Masāfat al-Nahr*	γ Eridani
11	*ᶜAyn al-Thawr*	α Tauri
12	*Rijl al-Jawzā' al-Yusrā*	γ Orionis
13	*Yad al-Jawza' al-Yusrā*	β Orionis
14	*Yad al-Jawzā' al-Yumnā*	α Orionis
15	*Rijl al-Jawzā' al-Yumnā*	κ Orionis
16	*Shiᶜrā Yamānī*	α Canis Majoris
17	*Shiᶜrā Shāmī*	α Canis Minoris
18	*Minkhar Shujāᶜ*	σ Hydrae
19	*Fard al-Shujāᶜ*	α Hydrae
20	*Ṭarfat al-Safīna*	ρ Puppis
21	*Qā'idat al-Bāṭiya*	α Crateris
22	*Janāḥ al-Ghurāb*	γ Corvi
23	*Al-ᶜAnāq*	ζ Ursae Majoris
24	*Simāk Aᶜzal*	α Virginis
25	*Simāk Rāmiḥ*	α Bootis
26	*Nayyir Fakka*	α Coronae Borealis
27	*ᶜUnuq al-Ḥayya*	α Serpentis

	Star Name	Identification
28	*Rukbat al-Ḥawwā’ al-Yusrā*	ζ Ophiuchi
29	*Rās al-Jāthī*	α Herculis
30	*Rās al-Ḥawwā’*	α Ophiuchi
31	*ᶜAyn al-Tinnīn*	γ Draconis
32	*Yad al-Ḥawwā’ al-Yumnā al-Muqaddam*	δ Ophiuchi
33	??	
34	*Nasr Wāqiᶜ*	α Lyrae
35	*Minqār al-Dajāja*	β Cygni
36	*Nasr Ṭā’īr*	α Aquilae
37	*Dhanab al-Dajāja*	α Cygni
38	*Fam al-Faras*	ε Pegasi
39	*Dhanab al-Jadī*	δ Capricorni
40	*Sāk Sākib al-Mā J[anūbī]*	δ Aquarii
41	*Mankib al-Faras*	β Pegasi
42	*Surrat atl-Faras*	δ Pegasi
43	*Kaff al-Kaḍīb*	β Cassiopeiae

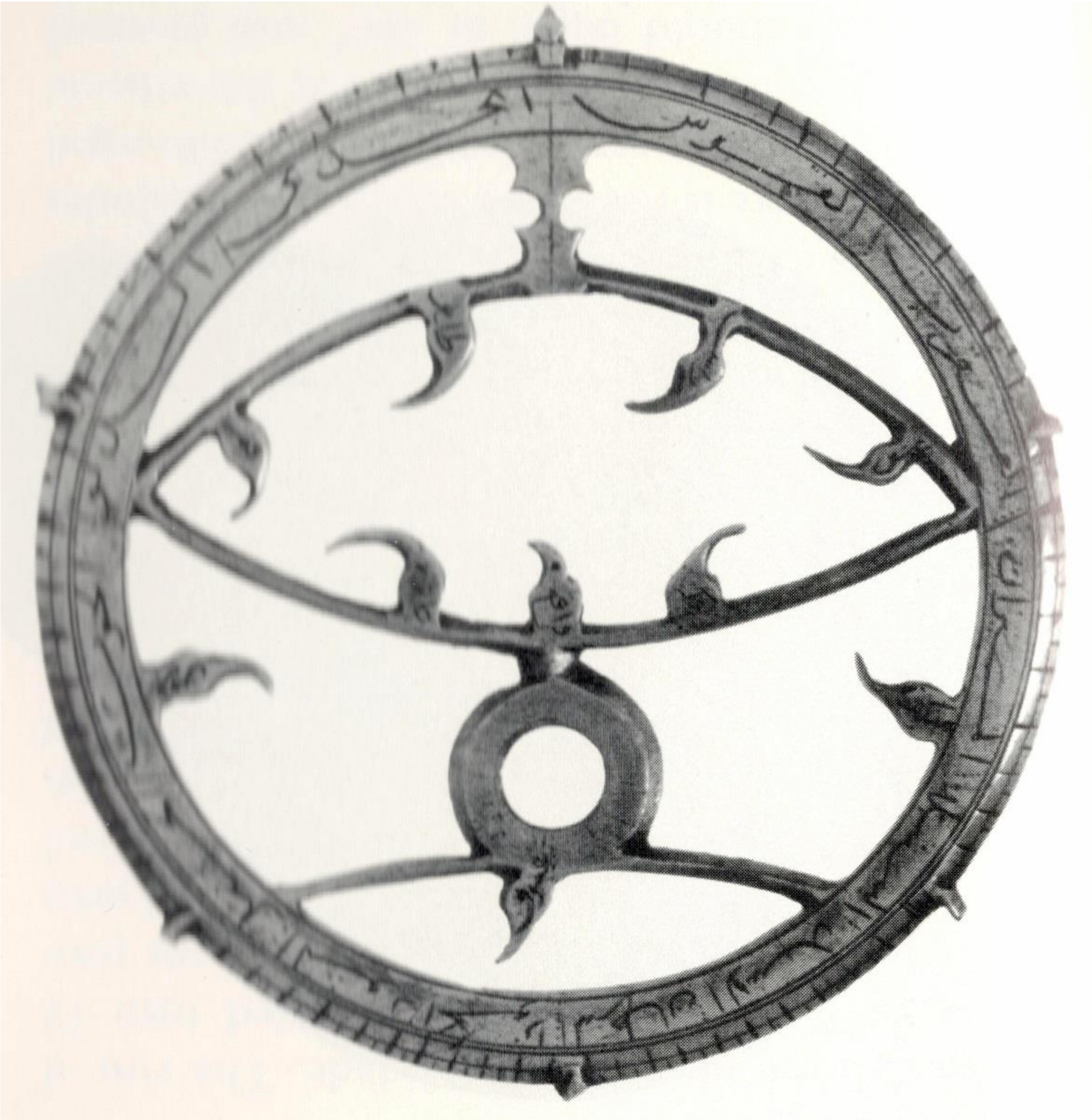

Figure A128.3 – The second Rete (from Gibbs & Saliba 1984)

RETE II

The second rete consists of just the ecliptic ring; it is reminiscent of the minimal rete Ḍiyā’ al-Dīn devised for his north-south astrolabe of 1674 (A090). It is divided into the 12 signs of the zodiac and is inscribed with their names. Each sign is divided into 5 and 10 parts on the edge. Three arcs cut across bearing the following 10 named star pointers which are shaped like tiger’s claws.

Table A128-2 Stars on the Rete II

	Star Name	Identification
1	*ᶜAyyūq*	α Aurigae

	Star Name	Identification
2	?	
3	*ᶜUnuq [al-Ḥayya]*	α Serpentis
4	*[Simāk] Rāmiḥ*	α Bootis
5	*Rās [al-Jāthī]*	α Herculis
6	*[Nasr] Wāqiᶜ*	α Lyrae
7	*[Nasr] Ṭā'ir*	α Aquilae
8	*Dhanab [al-Dajāja]*	α Cygni
9	*Fam [al-Faras]*	ε Cygni
10	*[Surrat al-] Faras*	δ Pegasi

PLATES

There are five plates with the following functions:

Table A128-3 Plates

	φ	Longest Day
1a	25°	13;25 hours
1b	27°	13;47 hours
2a	29°	13;52 hours
2b	32°	14;8 hours
3a	30°	13;53 hours
3b	38°	14;42 hours
4a	36°	14;32 hours
4b	40°	14;52 hours
5a	Tablet of ecliptic coordinates	
5b	Tablet of horizons	

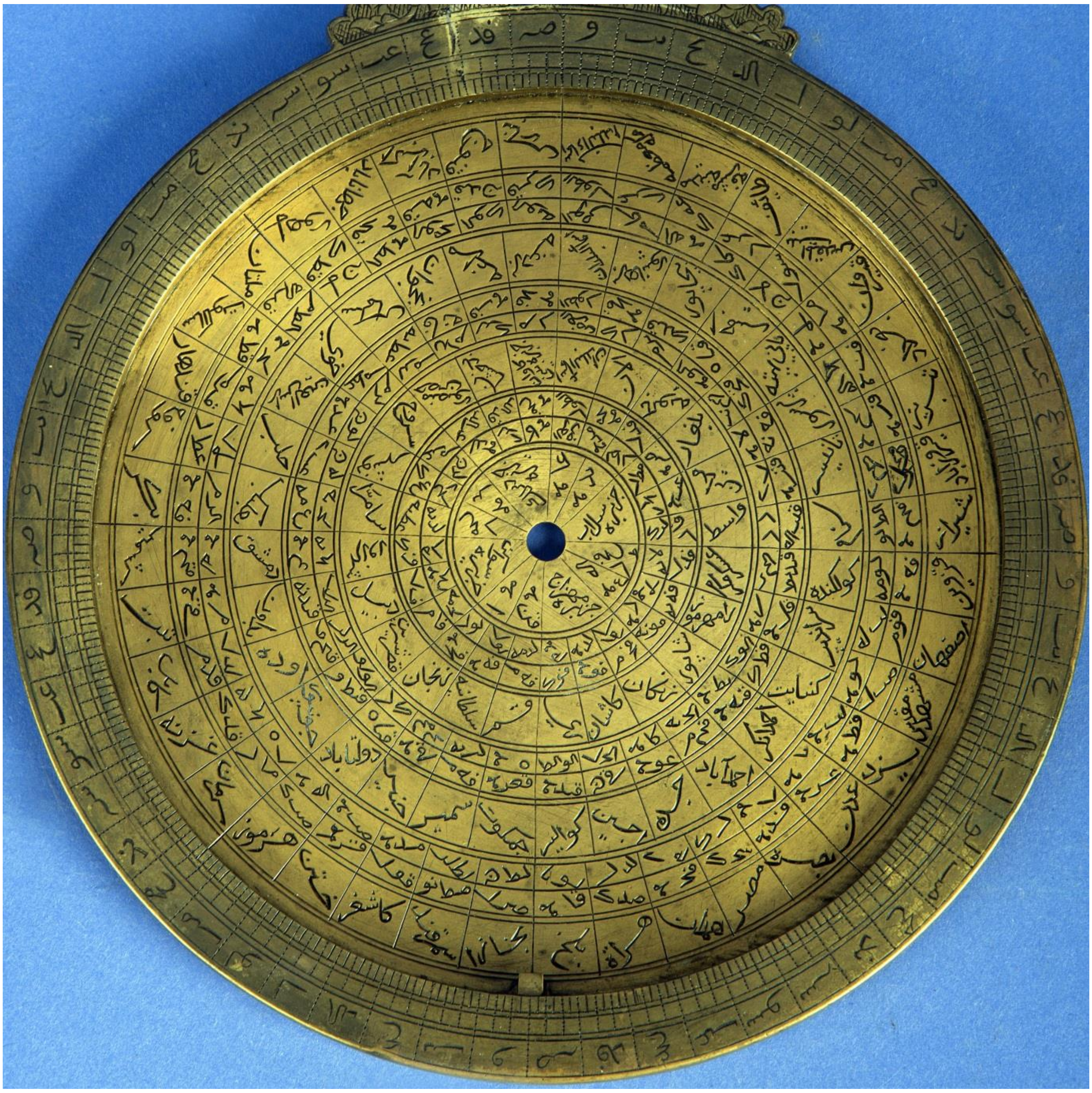

Figure A128.4 – Geographical Gazetteer
(© National Museum of American History, Washington, D.C.)

Geographical Gazetteer

The geographical gazetteer provides the names, longitudes and latitudes of 97 localities in three circles. The names are engraved upside-down with the tops of the letters towards the centre and the names and coordinates are arranged in a zigzag fashion. The grid is formed by six double circles intersected by segmented radial lines. The gazetteer commences with Mecca and proceeds up to India, but the localities appear to be arbitrarily arranged without any discernable pattern of increasing or decreasing longitudes or latitudes.

Table A128-4 Geographical Gazetteer

	Place Names *(asmā al-buldān)*	L *(al-ṭūl al)*	φ *(ᶜarḍ)*
	Outer Circle		
1	Makka Muᶜaẓẓam	77;10	21;40
2	Madīnat Musharrafa	75;20	25;00
3	Ṭā’īf	77;30	21;20
4	Bayt al-Maqdis	66;30	31;50
5	Qayrawān	41;0	31;0
6	Baghdād	82;0	33;25
7	Tabrīz	82;0	38;0
8	Fīrūzābād	87;30	28;10
9	Shīrāz	88;0	27;16
10	Qazwīn	85;0	36;45
11	Iṣfahān	86;40	32;35
12	Mashhad Maqdis	92;30	36;0
13	Yazd	89;0	32;0
14	ᶜAdan	77;0	11;0
15	Baṣra	74;0	30;0
16	Miṣr	63;20	30;20
17	Hamadān	83;0	35;10
18	Harāt	94;20	34;10
19	Balkh	101;0	36;11
20	Bukhārā	97;30	39;50
21	Samarqand	99;56	39;37
22	Kāshghar	106;30	45;0

	Place Names *(asmā al-buldān)*	**L** *(al-ṭūl al)*	**φ** *(ᶜarḍ)*
23	Khutan	107;?	42;0
24	Hurmūz	92;20	25;0
25	Kirmān	41;30	30;5
26	Ghazna	104;20	33;35
27	Kābul	104;40	34;30
28	Tubbat	110;0	40;0
29	Kashmīr	108;0	35;0
30	Bakar	105;0	27;0
31	Kūfa	79;30	31;30
32	Qandahār	107;40	33;0
33	Sālkūt	109;0	33;0
34	Multān	104;25	29;40
35	Lāhūr	109;20	31;50
36	Jahānābād (for Shāhjahānābad)	103;0	29;0
37	Akbarābād	115;0	26;43
38	Qannawj	114;50	26;20
39	Banāras	117;20	25;15
	Middle Circle		
40	Burhānpūr	113;0	20;30
41	Bījāpūr	114;20	17;40
42	Ajmīr	111;5	26;0
43	Pānīpatah	112;0	30;10
44	Parsūr	85;35	31;0

	Place Names *(asmā al-buldān)*	**L** *(al-ṭūl al)*	**φ** *(ᶜarḍ)*
45	Tānīsar	112;0	30;10
46	Sunām	112;25	30;30
47	Kūlkanda	114;19	28;4
48	Sarāndīb	130;0	10;0
49	Kanbayāt	109;20	26;20
50	Ahmadnakar	115;0	19;0
51	Ahmadābād	108;40	23;15
52	Jadda	108;40	23;15
53	Ujjayn	110;50	23;30
54	Kawāliyār	114;0	26;29
55	Jamkūt	174/7;0	5;0
56	Samīr[um]	85;40	32;15
57	Janīr ?	110;0	38;48
58	Dawlatābād	111;5	20;30
59	Jawnpūr	119;40	26;36
60	Awadh	118;6	27;32
61	Badāwan	114;55	27;32
62	Dimashq	70;0	33;15
63	Baᶜālbak	70;45	33;15
64	Ḥalab	72;10	35;50
65	Rās Alᶜayn	74;0	36;50
66	Khuway	79;40	37;40
67	Salmās	79;15	37;40
68	Nakhjawān	81;55	38;40

	Place Names *(asmā al-buldān)*	L *(al-ṭūl al)*	φ *(ᶜarḍ)*
69	Marāgha	82;0	37;20
70	Bardaᶜa	83;0	40;30
	Inner Circle		
71	Alān	83;0	44;0
72	Bākūya	84;30	39;30
73	Bulghār	90;0	49;30
74	Madā'īn	72;0	33;10
75	Wāsit	81;30	32;20
76	ᶜAskar Mukram	84;30	31;15
77	Rāmhurmūz	85;15	31;0
78	Shāpūr	86;55	30;0
79	Zankān	83;40	36;30
80	Kāshān	86;0	34;0
81	Rayy	86;20	35;0
82	Qumm	85;40	34;45
83	Sulṭāniyya	85;0	36;30
84	Zanjān	83;0	36;30
85	Qaṣr Shīrīn	81;40	33;45
86	Dabīl	80;30	38;0
87	Shahrazūr	80;20	35;30
88	Sāmarrā'	79;15	34;15
89	Nawshahr	78;20	38;10
90	Sarūj	72;40	34;50
91	Ḥiṣn Manṣūr	72;24	34;0

	Place Names *(asmā al-buldān)*	**L** *(al-ṭūl al)*	**φ** *(ᶜarḍ)*
92	Badakhshān	104;24	37;10
93	Jazīra Banī Kāwan	88;0	21;0
94	Jazīra Sulāb[534]	88;30	25;0
95	Jazīra Mahrāj	150;0	2;0
96	Jazīra Sawākin	48;30	17;0
97	Jazīra Dahlāk	71;0	14;0

BACK

The rim of the upper half carries the altitude scales which are divided in 1°, 2° and 6° and numbered in 6s as 6—90; 90—6. The upper left quadrant has 60 horizontal parallels to measure the cosine of each 1/60th part of the Radius; every sixth of these lines is emphasized with dots. The upper right quadrant is engraved with declination arcs, one for each 10° of solar longitude. Every third of these, forming the boundary between two successive signs, is dotted. The names of the corresponding zodiac signs are written along the two radii together with the numerical values of their subdivisions, viz., 10, 20, 30. Two sigmoid curves for the midday latitude of the sun in all seasons are plotted in this quadrant with the labels *khaṭṭ niṣf al-nahār bi-ᶜarḍ 27* and *khaṭṭ niṣf al-nahār bi-ᶜarḍ 32*.

534 These four names are engraved inside the third circle around the centre.

Figure A128.5 – Back of the Astrolabe
(© National Museum of American History, Washington, D.C.)

In the lower half, below the horizontal diameter are engraved the shadow squares. The square on the left is for a gnomon of 12 digits and 60 units. Here the vertical and horizontal scales are divided into 12 units each; each unit is again subdivided into 5 divisions. These are numbered in 5s from 5 to 60. The vertical scale is accompanied by

the label *ẓill sullam sattaynī aṣābiʿ maʿkūs* and the horizontal scale by *ẓill sullam sattaynī aṣābiʿ mustawī.*

On the right is the shadow square for a gnomon of 7 feet. The vertical and horizontal scales are divided accordingly into 7 parts and numbered from 1 to 7. The vertical scale carries the label *ẓill sullam aqdām maʿkūs* and the horizontal scale *ẓill sullam aqdām mustawī.*

These shadow squares enclose three rectangular scales; one long table below and two shorter tables above. The longer table bears the title *jadwal faḍl al-dawr* (excess of revolution) and provides multiples (of 1, 2, 3 …9 and 10, 11, 12 … 90) of the difference between the correct length of the year and 365 days. The short table above it on the left is the table of triplicities with the heading *jadwal arbāb muthallathāth laylī wa nahārī* (table of the regents of the triplicities, nocturnal and diurnal). The table on the upper right is entitled *jadwal ʿarḍ iqlīm wa sāʿāt niṣf al-nahār* (table of the latitudes of climates and the hours of the midday ?). It gives the latitudes and the lengths of the maximum daylight at the beginning and middle of the seven climates.[535]

Figure A128.6 – Tables inside the shadow Squares (detail of Figure A128.5)

535 Cf. A048; Kaye 1918, p. 132. Gibbs & Saliba 1984, p. 167, say that the 'table gives the length of longest daylight in hours and the corresponding latitude for the upper and lower limits of the seven "climates".' It is not the upper limits but the midpoints of the climates.

Table A128-5 Table of Climates

	climate		hours	latitude
I	*awwal*	*ibtidā’* (beginning)	12;45 h	12;48°
		wāsiṭ (middle)	13;0	16;47
II	*dūyam*	*ibtidā’* (beginning)	13;15	20;31
		wāsiṭ (middle)	13;30	24;2
III	*sīwum*	*ibtidā’* (beginning)	13;45	27;34
		wāsiṭ (middle)	14;0	30;45
IV	*cahārum*	*ibtidā’* (beginning)	14;15	33;43
		wāsiṭ (middle)	14;30	36;28
V	*panjum*	*ibtidā’* (beginning)	14;45	39;1
		wāsiṭ (middle)	15;0	41;21
VI	*shashum*	*ibtidā’* (beginning)	15;15	43;30
		wāsiṭ (middle)	15;30	45;39
VII	*haftum*	*ibtidā’* (beginning)	15;45	47;38
		wāsiṭ (middle)	16;0	48;59

The shadow squares are enclosed by a series of semi-circular rows. The three outermost rows on the rim of the lower half are engraved with cotangent scales and their subdivisions. These are followed by 6 semi-circular rows containing the names of the 28 lunar mansions, the names of the 12 zodiac signs, the planetary lords of the limits and the regents of the decans.

Figure A128.7 – Alidade
(© National Museum of American History, Washington, D. C.)

ALIDADE

The alidade has ornate ends and an ornate centre-piece. It is engraved with three scales; on the right are a sexagesimal scale and a scale of seasonal hours and on the left a zodiac scale containing the serial numbers of the signs and their subdivisions of 10°.

BIBLIOGRAPHY

Gibbs & Saliba 1984, no. 2569, pp. 165-169.

A129⊙ ASTROLABE ATTRIBUTABLE TO THE LAHORE WORKSHOP

Not dated, 17th century

Diameter 240 mm

Paris, PC

Figure A129.1 – Front of the astrolabe (photo by S. R. Sarma)

The astrolabe is well made, the *kursī* is reminiscent of Muqīm's work, the rete is elegantly designed and the gazetteer lists many Indian localities which are not mentioned in other astrolabes. But the arrangement of the cells in the gazetteer is not symmetric and Delhi is listed as Jahānābād as in A128. There are inconsistencies in the plates as well. On the back, the engravings on large areas are removed by crude chiselling on the surface.

COMPONENTS

Body with *kursī* (d. 240, h. 308, t. 9), shackle and ring, rete (d. 226), 5 plates, alidade, pin and horse.

FRONT

The ring is plain; the shackle trifoliate with ornate bases; the *kursī* is elegantly reticulated with six large perforations. The profiles are made up of ogees at the base and the top with a lobe between them with a trifoliate finial. The limb divided in 1° and 6° and numbered in 6s from 6 to 360.

RETE

The Capricorn and the broader ecliptic ring are held together by the slender equinoctial bar which is counter-changed once at the centre. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names, each sign is divided into units of 6° and numbered accordingly. The edge of the ecliptic ring is divided in 1°. There are some 40 named star pointers; one pointer is broken. An ornate handle is on the left segment of the equinoctial bar. In contrast to the handle, the Capricorn index with a flat tip is not well shaped.

Figure A129.2 – Rete of the astrolabe (photo by S. R. Sarma)

PLATES

There are 5 plates serving different latitudes. The choice of latitudes is rather strange. Projections for latitude 26° is repeated on two plates. The maximum duration of the daylight is not carefully chosen.

Altitude circles are drawn for each 1° with every sixth dotted. Azimuth arcs are drawn below the horizon for each 6°. There are plain lines for seasonal hours and dotted lines for equal hours drawn from the western horizon.

There is no plate for the ecliptic coordinates and multiple horizons.

Table A129-1 Plates

	φ	**Longest Day**
1a	24°	13;29 hours
1b	26°	13;38 hours
2a	26°	13;38 hours
2b	29°	13;12 hours!
3a	28°	13;47 hours!
3b	30°	13;36 hours
4a	31°	14;1 hours
4b	33°	14;11 hours
5a	32°	14;6 hours
5b	35°	14;22 hours

GEOGRAPHICAL GAZETTEER

The gazetteer is arranged in three circles, which are not divided symmetrically. The outer circle is divided into 49 cells, the middle circle into 25 cells, but the inner circle into 20 cells. Of the 91 localities listed along with their longitudes and latitudes, some 70 are from Mughal India, which too is unusual. On the other hand, there is no discernible pattern of arrangement. The listing begins with Mecca, Medina and Jerusalem, enumerates some 70 places in Mughal India, and concludes with localities in the Middle East. Shāhjahānābād is misspelt as Jahānābād. Several place names are difficult to decipher.

Figure A129.3 – Geographical Gazetteer (photo by S. R. Sarma)

Table A129-2 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
1	Makkā Mubarak	77;10	21;40
2	Madīnat Rasūl	75.20	25; ?
3	Bayt al-Maqdis	66;30	32;15
4	Miṣr	63;20	30;20
5	Iṣfahān	86;40	32;25
6	Balkh	101;0	36;41

	Place Name	L	φ
7	Badakhshān	105;24	37;0
8	Baghdād	80;0	35;25
9	Bulghār	90;0	49;30
10	Baṣrā	84;0	30;0
11	Bukhārā	97;0	39;50
12	?	69;16	39;37
13	Qandahār	107;40	33;0
14	Daubul ᶜAraftatah (?)	102;30	25;12
15	?	104;25	26;40
16	Bahkar (?)	105;0	27;40
17	Mūltān	107;35	29;40
18	Kīch az Makrān	99;0	28;0
19	Ghaznī	104;5	35;20
20	Kābul	105;0	34;30
21	Jalālābād	104;40	34;10
22	Pīshāwar	106;40	33;50
23	?	?	?
24	Rahnās (?)	?	32;45
25	Kashmīr	108;0	35;0
26	Tubbat	110;0	40;0
27	Kach az Shān (?)	108;35	32;30
28	Bahīra (?)	108;0	31;40
29	Lāhūr	109;20	31;50
30	Lūdhiyānā	110;40	31;10

	Place Name	L	φ
31	Sarhind	111;30	30;30
32	Sunām	111;30	29;30
33	??	112;0	30;0
34	Hardwār	113;0	30;0
35	Sar[c] ankar (?)	112;52	33;10
36	Kānkarā (Kangra?)	111;35	33;35
37	Kīrānā (?)	113;20	29;40
38	Sūrat	108;10	21;25
39	Patan Kujarāt	107;25	23;35
40	Naharbār (?)	109;40	21;0
41	Burhānpūr	112;20	21;30
42	Aurankābād	111;30	19;0
43	Bīdar	110;3	18;39
44	Kūlkandā	114;45	18;35
45	Bījāpūr	113;25	17;0
46	Mandū	111;36	22;0
47	Ujjayn	112;30	22;15
48	Sarūnj	114;42	24;48
	Middle Circle		
49	Narwar	114;55	25;30
50	Jahānābād (Shāhjahānābād)	113;35	28;34
51	Hānsī Hissār	112;0	29;45
52	Amrūhā	114;45	28;40
53	Sanbhal	114;40	28;32

	Place Name	L	φ
54	Akbarābād	115;0	26;43
55	Ajmīr	111;5	25;50
56	Ahmadābād Kujarāt	108;20	23;0
57	Kawāliyār	114;56	25;56
58	Kālpī	116;0	27;35
59	Qannawj	116;15	26;55
60	Bahrāīch	116;30	28;0
61	Allāhābād	116;50	26;12
62	Banāras	117;20	27;0
63	Jawnpūr	117;6	27;11
64	Patnā	119;12	26;40
65	Mūnkīr	120;0	27;6
66	Rājmahal	121;5	25;15
67	Kawr Bankālā (Gaur in Bengal)	121;12	25;0
68	Udīsā (?)	120;0	18;0
69	Dhākā	122;0	23;35
70	Sulṭānpūr	115;0	28;30
71	Pānīpat	113;10	28;52
72	Sālkūt	109;0	33;0
	Inner Circle		
73	Mīwāt	117;10	32;50
74	Baran	114;0	28;48
75	Kūl	114;19	28;4

	Place Name	L	φ
76	Mānikpūr	118;10	26;45
77	Khujand	109;36	41;55
78	Awad[h]	118;7	26;32
79	Thānīsar	117;38	?.?
80	Nīshābūr	86;55	30;?
81	Lankā	11;0	0;0
82	Jamkūt	170;0	5;0
83	Fīrūzābād	87;0	28;30
84	Qurqur (?)	65;15	50;40
85	Mārī Kirmān	65;45	50;45
86	Kāzirūn	87;0	30;0
87	Sawādaq (?)	66;0	31;0
88	Ḥalab	72;10	35;50
89	Sabarwār (?)	91;30	36;0
90	Kirmān	91;30	30;5
91	Ghāzīpūr	119;40	26;40

BACK

The back of the astrolabe is planned quite ambitiously as can be seen still in the two upper quadrants. The rim of the upper half carries two altitude scales divided in 1° and in 6° and numbered in 6s as 6---90; 90---6.

Figure A129.4 – Back of the astrolabe (photo by S. R. Sarma)

The upper left quadrant is engraved with a sine-cosine graph with 60 horizontal and 60 vertical parallels where each sixth line is dotted. The horizontal lines are numbered in 5s along the vertical radius. Semicircles are drawn on the two radii. Radial lines connect the centre with the arc at every 15°. Furthermore, 6 quarter circles (which

form the boundaries between two zodiac signs) from the upper right quadrant are extended into this quadrant.

The upper right quadrant carries 6 dotted quarter circles, dividing the area into 6 segments, one for each pair of zodiac signs. Each segment is divided by 5 quarter circles into 6 parts so that each part represents 5° of solar longitudes.[536] The names of the corresponding signs and their 1/6th parts in degrees (5, 10, 15, 20, 25, 30) are engraved along the two radii. Three sigmoid graphs of the solar meridian altitude for the latitudes 27°, 29° and 32° are engraved with the usual labels.

In the lower half are drawn the shadow squares, on the left for 12 digits and on the right for 7 digits with the usual labels in bold letters. It was planned to insert the table of excess of revolution inside the shadow squares; for this purpose, a grid of 4 columns is drawn, the name of the table *jadwal faḍl al-dawr* is engraved at the top and the arguments in the two outer columns, but the actual values of the multiples are not filled in.

The rim of the lower half carries two cotangent scales and their subdivisions. The unequal divisions in the scale on the left are numbered as 6, 12, 18, 24, 36, 48, 60, followed by the label *aṣābiᶜ*. The unequal divisions in the scale on the right are numbered as 7, 14, 21, 28, 59, followed by the label *aqdām.*

Inside these cotangent scales, 8 semi-circular rows are drawn and filled with different scales. But 5 of these scales ((i.e. rows 1, 5-8 as counted from the outside) were erased by crudely chiselling the surface for reasons unknown. Row 2 carries the names of the 12 signs of the zodiac and row 3 the names of the corresponding 28 lunar mansions. In the next row, under each lunar mansion, three numbers in *abjad* notation are engraved. Thus under the first lunar mansion *sharṭayn* the numbers are 0, 0, 0; under the second lunar mansion *buṭayn* the numbers are 0. 12, 11. The significance of these numbers is not known.

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[536] Five parts of 6° each is the more usual practice.

ALIDADE ETC

The straight alidade with ornate ends and an ornate centre-piece is not graduated. The tip of the pin is decorated with an elegant flower of six petals. The end of wedge is shaped like a horse’s head with eyes and ears.

A130⊙ ASTROLABE ATTRIBUTABLE TO THE LAHORE WORKSHOP

Not dated, 17th century

Diameter 204 mm

Patna, Khuda Bakhsh Oriental Public Library

Figure A130.1 – Front view of the astrolabe (photo by S. R. Sarma)

This is a massive and ambitious astrolabe, but it is poorly made with an inelegant rete. It is also quite worn out. The configuration on the back with the curves for the solar

meridian altitude and the several astrological tables and also the plate marked with astrological houses at latitudes 27°, 29° and 32° indicate that the astrolabe was produced in the Lahore family. I regret that I do not have good photos of this astrolabe.

COMPONENTS

Body with *kursī* (d. 204, h. 241, t. 13), swivel ring, shackle, rete (d. 183) for 45 stars, 8 plates, alidade and pin. The horse is missing; in its place an index belonging to a quadrant is used as a wedge.

FRONT

The ring is attached to the top of the shackle in such a manner that it can swivel all around. The *kursī* is solid and low with lobed profiles. It is made separately and joined to the main body, rather crudely, with two nails. The limb is divided in 1° and 6° and labelled from 6 to 90 clockwise, separately in each quadrant.

RETE

The peripheral Capricorn ring and the eccentric ecliptic ring are held together by the equinoctial bar which has two counter-changes at its two intersections with the ecliptic ring. The solstitial bar is also represented fully, but it often merges with the tracery that connects the star pointers. The ecliptic ring is divided into the 12 signs of the zodiac and labelled with their names; each sign is divided into units of 6° and numbered 6 to 30; the bevelled edge is graduated in 2°. There is a handle affixed to the pointer of the star α Hydrae. The Capricorn index is not sharply pointed. There are 45 named star pointers that are joined by a most inelegant tracery.

Figure A130.2 – Rete of the astrolabe (photo by S. R. Sarma)

Table A130-1 Stars on the Rete

	Star Name	Identification
01	*Dhanab al-Qayṭus [Janūbī]*	β Ceti
02	*Baṭn al-Ḥūt*	β Andromedae
03	*Fam al-Qayṭus*	γ Ceti
04	*Ṣadr al-Qayṭus*	π Ceti
05	*Rās al-Ghūl*	β Persei
06	*Kaff al-Jadhmā'*	α Ceti

	Star Name	Identification
07	*Tālī Masāfat al-Nahr*	γ Eridani
08	*ᶜAyn al-Thawr*	α Tauri
09	*ᶜAyyūq*	α Aurigae
10	*Rijl al-Jawzā’ al-Yusrā*	β Orionis
11	*Yad al-Jawzā’ al-Yusrā*	γ Orionis
12	*Yad al-Jawzā’al-Yumnā*	α Orionis
13	*Rijl al-Jawzā’ al-Yumnā*	κ Orionis
14	*Shiᶜrā Yamānī*	α Canis Majoris
15	*Shiᶜrā Shāmī*	α Canis Minoris
16	*Ṭarfat al-Safīna*	ρ Puppis
17	*Minkhar al-Shujāᶜ*	σ Hydrae
18	*Fard al-Shujāᶜ*	α Hydrae
19	*Qalb al-Asad*	α Leonis
20	*Qāᶜidat al-Bāṭiya*	α Crateris
21	*Ṣarfa*	β Leonis
22	*ᶜAnāq*	ζ Ursae Majoris
23	*Janāḥ al-Ghurāb*	γ Corvi
24	*Simāk al-Aᶜzal*	α Virginis
25	*Simāk Rāmiḥ*	α Bootis
26	*Nayyir al-Fakkā*	α Coronae Borealis
27	*ᶜUnuq al-Ḥayyā*	α Serpentis
28	*Qalb al-ᶜAqrab*	α Scorpii
29	*Rukbat al-Ḥawwā al-Yusrā*	ζ Ophiuchi
30	*Rās al-Jāthī*	α Herculis

	Star Name	Identification
31	*Rās al-Ḥawwā*	α Ophiuchi
32	*Yad al-Muqaddam Yumnā*	δ Ophiuchi
33	*Nasr Wāqiᶜ*	α Lyrae
34	*Minqār al-Dajāja*	β Cygni
35	*Nasr Ṭā'ir*	α Aquilae
36	*Dhanab al-Dulfīn*	ε Delphini
37	*Dhanab al-Dajāja*	α Cygni
38	*Fam al-Faras*	ε Pegasi
39	*Dhanab al-Jadī*	δ Capricorni
40	*Mankib Sākib al-Mā'*	α Aquarii
41	*Sāq Sākib al-Mā'*	δ Aquarii
42	*Dhanab al-Qayṭus [Shamālī]*	ι Ceti
43	*Janāḥ al-Faras*	γ Pegasi
44	*Surrat al-Faras*	δ Pegasi
45	*Kaff al-Khaḍīb*	β Cassiopeiae

PLATES

There are eight plates. A ring is added to the rim of plate 6 to increase its thickness. Plates 1 to 5a are engraved with altitude circles for each 2°, with every fifth highlighted with dots. In the lower half, there are plain lines for seasonal hours and dotted lines drawn from the western horizon for equal hours. Care is not taken to write on the plates the exact duration of the maximum daylight.

Table A130-2 Plates

	φ	Longest Day
1a	21°	13 hours!
1b	24°	13 hours!
2a	26°	13 hours!
2b	27°	13 hours!
3a	29°	13;52 hours
3b	32°	14;8 hours
4a	34°	14 hours!
4b	36°	14 hours!
5a	30°	14 hours!
5b	double projection of 90° + 72°	
6a	38°	15 hours!
6b	double projection of 42 + 48°	
7a	Tablet of ecliptic coordinates with the label *ṣafīḥat mīzān al-ᶜankabūt*	
7b	Tablet of horizons with the label *ṣafīḥa āfāqī*	
8a	Astrological houses at latitude 27°	
8b	Astrological houses at latitudes 29° and 32°	

Plate 8 deserves attention. On the obverse side, arcs are drawn to indicate astrological houses at latitude 27° with the label *ṣafīḥat maṭraḥ shuᶜāᶜ bi-ᶜarḍ 27* (plate for finding astrological rays at latitude 27°). On the reverse side, astrological houses at latitude 29° are marked in one half and the same for the latitude 32° in the other half with labels *ṣafīḥat maṭāriḥ shuᶜāᶜ bi-ᶜarḍ 29* and *ṣafīḥat maṭārḥ shuᶜāᶜ bi-ᶜarḍ 32* respectively (see Figure A099.3) To facilitate the use of these two halves, notches are made at the north and south points of this plate, while all other plates have a single notch

at the north point. On both sides of the plate, names of the 12 zodiac signs are engraved along the rim together with their subdivisions marked as 6, 12, 18, 24 and 30.

Geographical Gazetteer

The geographical gazetteer provides the names and coordinates of 81 localities in three circles, each separated from the others by a blank annulus. The enumeration commences with Mecca and Medina in the inner circle. Kannauj (no. 58) is given the attribute ‘Dār al-Mulk Hind’ (Capital City of India), obviously borrowed from Ulugh Beg’s gazetteer (see also A072).

Table A130-3 Geographical Gazetteer

	Place Name	L	φ
	Inner Circle		
1	Makka Mu^cazzam	77;10	21;40
2	Madinat Munawwara	75;20	25;0
3	Mahdiyya Maghrib	52;05	32;30
4	Iskandariyya	61;54	30;38
5	Miṣr	68;20	30;20
6	Sana^cā Dar-al Mulk Yaman	77;10	15;30
7	Dimashq	70;0	38;55
8	Ba^calback	70;55	38;58
9	Ḥalab	72;10	35;50
10	Qustantiniyya	59;50	45;00
11	Arzan Rūm	77;00	39;40
	Middle Circle		
12	Mawṣil	77;0	34;30
13	Tabrīz	86;0	38;0

	Place Name	L	φ
14	Bardaᶜa	88;0	40;30
15	Bulghār	95;0	49;30
16	Kūfa	79;30	31;30
17	Madāin	72;0	38;25
18	Baghdād	80;30	38;25
19	Baṣra	84;0	30;0
20	Shīrāz	88;0	29;36
21	Yazd	89;0	32;30
22	Hamadān	88;0	35;10
23	Karkh	84;45	34;0
24	Kazwīn	85;5	36;55
25	Iṣfahān	86;40	32;25
26	Rayy	86;20	35;0
27	Astarābād	89;30	36;55
28	Jurjān	95;0	36;55
29	Bisṭām	89;30	36;10
30	Sabzawār	91;30	36;5
31	Nyshābūr	92;30	36;21
32	Ṭūs	94;30	37;0
33	Tūn	92;30	32;30
34	Harat	94;38	34;30
	Outer Circle		
35	Sarakhs	94;0	32;0
36	Marw	97;0	34;40

	Place Name	L	φ
37	Balkh	101;0	36;41
38	Badakhshān	104;27	37;10
39	Bukhārā	97;30	39;50
40	Samarqand	99;56	39;37
41	Khujand	105;10	41;55
42	Kāshghar	106;30	44;0
43	Hurmūz	92;0	25;0
44	Aḥmadābād	108;40	23;28
45	Ujjayn	104;0	23;0
46	Kābul	104;40	34;40
46	Mewāt	117;50	32;50
48	Badā'ūn	114;59	27;32
49	Hānsī	112;35	29;15
50	Akbarābād	114;0	27;18
51	Dihlī	118;0	28;20
52	Ajmīr	111;05	26;0
53	Kawāliyar	105;08	26;29
54	Kashmīr	108;0	35;40
55	Tubbat	110;0	40;0
56	Sarandīb	104;0	10;0
57	Banāras	117;20	26;55
58	Qannawj Dār al-Mulk Hind	105;50	26;50
59	Lāhūr	109;20	31;50
60	Qandahār	107;40	38;0

	Place Name	L	φ
61	Multān	104;40	29;40
62	Sultānkūt	109;0	28;10
63	Mashhad	105;0	28;10
64	Khamabayāt	109;00	28;0
65	Jadda	76;0	21;0
66	Burhānpūr	109;0	21;20
67	Bījāpūr	109;0	17;20
68	Dawlatābd	112;0	20;40
69	Gopāmāū	106;35	27;45
70	Mānikpūr	118;-	27;49
71	Awadh	118;06	27;22
72	Purshawār	104;55	31;50
73	Mansūrā Sind	104;0	27;40
74	Baran	114;0	28;48
75	Kūl	114;39	28;10
76	Aḥmadnakar	106;0	19;0
77	Kūlkunda	114;35	18;10
78	Surunj	72;40	34;50
79	Kalpī	116;45	26;45
80	Dhākā Bangālā	130;0	27;0
81	Lakhnaū	114;10	26;30

Back

On the back of the astrolabe, the rim of the upper half is engraved with altitude scales which are divided in 1°, 2° and 6° and labelled as 6---90; 90---6.

The trigonometric quadrant in the upper left carries 60 vertical and 60 horizontal parallels with every sixth line dotted. Semi-circles are drawn on both the radii; also quarter circles at 12 units and 23;30 units of the radii. The solar quadrant on the upper right is divided by 18 declination arcs, with each third highlighted with dots. The names of the corresponding zodiac signs are written along the two radii. Five curves of the meridian altitude of the sun in all seasons at latitudes 21°, 27°, 29°, 32° and 36° are plotted on this quadrant. To the last curve is added the full label *khaṭṭ niṣf al-naḥār bi-ᶜarḍ 36;* in the case of other curves, just the latitude is mentioned.

In the lower half are the double shadow squares, on the left for the base of 12 and 60 and on the right for the base of 7. Inside the squares, there are five concentric semi-circles bearing the tables of the limits and faces.

The rim of the lower half carries cotangent scales in feet and in digits. Inside these scales are two semi-circular rows carrying the names of the 12 zodiac signs and the names of the 28 corresponding lunar mansions.

ALIDADE

The alidade has ornate ends and a simple centre-piece. The right half carries a sexagesimal scale numbered in 6s from 6 to 60 to match with the trigonometric quadrant. The left half is divided into the signs of zodiac. The sighting plates have three apertures of different dimensions. The pin has an ornate tip. The horse is lost. In its place, the graduated index of a quadrant (which is no more extant) is used.

A131⊙ ASTROLABE ATTRIBUTABLE TO THE LAHORE WORKSHOP

Not dated, 17th century

Diameter 124 mm

Jaipur, Jai Singh’s Observatory

CCA 76

Figure A131.1 – Front of the astrolabe (photo by S. R. Sarma)

This small but exquisitely fashioned astrolabe carries no signature or date; it contains many elements not found in Lahore astrolabes, especially on the back. The horizontal lines in the trigonometric quadrant are not evenly spaced. In the solar quadrant, there are no curves of the midday altitude of the sun; instead there is a universal horary quadrant. There are no shadow squares in the lower half. Even so, the well-crafted *kursī* and rete and the gazetteer arranged by climates suggest that the astrolabe may have emanated from the workshop of the Lahore Family.

COMPONENTS

Body with *kursī* (d. 124), shackle, ring, rete, 5 plates, alidade, pin and wedge.

FRONT

The shackle is trifoliate with trowel-like bases. The *kursī* is rather high; it is reticulated intricately and very elegantly to produce tulip-like flowers with long stems. The finial is trifoliate. On the vertical axis there are two floral ornaments one below the other.

The trefoil motif is frequently repeated; in the finial, in the perforation at the top of the *kursī,* in the two floral ornaments immediately below, and again in the rete in the frame surrounding the bird-like pointer of the star α Lyrae and immediately below the ecliptic ring. The limb is graduated in 1° and 5° and numbered in 5s from 5 to 90 clockwise, separately in each quadrant. The numbers are so written that their tops are towards the centre.

RETE

The two rings of the Tropic of Capricorn and the ecliptic are held together by the equinoctial bar without counter changes. Unusually for a Lahore astrolabe, a segment of the equator ring is represented in the lower half. The ecliptic ring is divided into the 12 signs of the zodiac, with their names engraved neatly in each division. The signs are divided in groups of 6° and are numbered from 6 to 30 clockwise.

The star pointers are joined by a perfectly symmetric tracery consisting of straight and inverted arch-like frames. A small segment of the solstitial bar is shown below and above the central ring. The pointer of the star *Nasr Wāqiᶜ* (falling eagle) is depicted as a bird with outstretched wings perched on the upper segment of the solstitial bar. The bird is framed by a trifoliate form. There are 21 leaf-shaped star pointers. A handle to rotate

the rete is placed on the tracery on the meridian between the ecliptic ring and the peripheral ring. It too has a trifoliate form when seen from the side.

Figure A131.2 – Rete of the astrolabe (photo by S. R. Sarma)

Table A131-1 Stars on the Rete

	Star Name	Identification
1	*Al-Ḥūt*	β Andromedae
2	*Fam al-Qayṭus*	γ Ceti
3	*Ghūl*	β Persei
4	*Al-Dabarān*	α Tauri
5	*ᶜAyyūq*	α Aurigae
6	*Al-Rijl*	β Orionis

	Star Name	Identification
7	*Yad*	γ Orionis
8	*Nathra*	ε Cancri
9	*al-Shāmī*	α Canis Minoris
10	---	
11	*Fard*	α Hydrae
12	*Qalb al-Asad*	α Leonis
13	*Sāq ??*	
14	*Al-Aᶜzal*	α Virginis
15	*Al-Rāmiḥ*	α Bootis
16	*Al-Fakka*	α Coronae Borealis
17	*Qalb al-ᶜAqrab*	α Scorpii
18	*Al-Ḥawwā'*	α Ophiuchi
19	*Al-Wāqiᶜ*	α Lyrae
20	*Ṭā'ir*	α Aquilae
21	*Al-Dajāja*	α Cygni
22	*Dhanab al-Jadī*	δ Capricorni
23	*Mankib*	α Aquarii
24	*Dhanab al-Qayṭus*	ι Ceti

PLATES

There are five plates; they all carry a hole a little above the north point so that they are held in position by a pin at the corresponding place in the mater.

Table A131-2 Plates

	φ	Longest Day
1a	18°	13;6 hours
1b	21°	13;18 hours
2a	24°	13;31 hours
2b	36°	14;32 hours
3a	27°	
3b	42° ?	
4a	28°	
4b	32°	
5a	40°	
5b	Tablet of horizons	

On the plates serving latitudes, altitude circles are drawn for every 6° and azimuth arcs for each 10°. On some plates, the hours of maxim duration of the daylight are not mentioned. In the lower half there are plain lines for seasonal hours and dotted lines for equal hours drawn from the western horizon; on some plates the dotted lines for equal hours are drawn from both the horizons. On all plates there are labels *maghrib* near the west point and *mashriq* near the east point.

On the tablet of horizons on 5b, half horizons are drawn in four sets, together with declination scales along the radii on either side of the equator circle. The scales are divided in 2 units and numbered in 6s from 6 to 24; the accompanying labels reads *al-mayl al-kullī* (maximum declination).

Geographical Gazetteer

The geographical gazetteer is arranged by climates in four annuli. In the first annulus are engraved the names of the climates, followed by place names, longitudes and latitudes, however, without the argument in the first cell. For each climate, five localities are chosen so that the gazetteer covers 35 localities. The four annuli occupy

just about the two-thirds of the space on the inner surface of the mater and the rest of the space in the middle is empty.

Figure A131.3 – Geographical gazetteer (photo by S. R. Sarma)

Table A131-3 Geographical Gazetteer

	Place Name	L	φ
	Outer Circle		
[I] *al-iqlīm awwal min khaṭṭ al-istiwā’ ilā ᶜarḍ 20;27* (the first climate from the line of equator to latitude 20;27°)			

	Place Name	L	φ
1	Arīn al-Arṣāmah (?)	90;0	0;0
2	ᶜAdan	59;45	14;0[537]
3	Sarāndīb	130;0	10;0
4	Madīna	18;0	14;0
5	Ṣānᶜnah (?)	76;0	15;30
[II] *al-thānī min 20;27 ilā ᶜarḍ 27;30* (the second [climate] from 20;27° to latitude 27;30°)			
6	Makka	77;0	21;40
7	Madīnat Rasūl	75;0	25;0
8	Jawnpūr	119;6	26;16
9	Banāras	119;20	26;15[538]
10	Awadh	118;30	26;22
[III] *al-thālith min 27;30 ilā ᶜarḍ 33;37* (the third [climate] from 27;30° to latitude 33;37°)			
11	Dihlī	113;35	28;39
12	Lāhūr	109;20	31;50
13	Kashmīr	108;55	35;0
14	Akra	115;0	24;43
15	Qannawj	115;50	26;35
[IV] *al-rābiᶜ min 33;37 ilā ᶜarḍ 38;54* (the fourth [climate] from 33;37° to latitude 38;54°)			
16	Harat	96;20	34;30

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537 By mistake, the engraver interchanged the longitude and latitude here.

538 Erroneously 16;15 instead of 26;15.

	Place Name	L	φ
17	Qazwīn	85;0	34;55
18	Balkh	--;0 !	36;41
19	Tabrīz	83;35	38;0
20	Badakhshān	107;24	36;10
[V] *al-khāmis min 33;54 ilā ᶜarḍ 43;22* (the fifth [climate] from 33;54° to latitude 43;22°)			
21	Samarqand	99;30	39;34
22	Bukhārā	94;30	39;50
23	Khwārizm	94;0	42;47
24	Farghān[a]	92;0	42;0
25	Adharbayjān	89;0	0;3 !
[VI] *al-sādis min 43;22 ilā ᶜarḍ 47;12* (the sixth [climate] from 43;22° to latitude 47;12°)			
26	Qustantiniyya	89;50	45;0
27	Awrkand	82;50	44;51
28	Al-Bāligh	82;30	44;0
29	Bīsh Bāligh	81;30	45;50
30	Qarāqurum	115;0	46;30
[VII] *al-sābiᶜ min 47;12 ilā ākhir al-ᶜimārat* (the seventh [climate] from 47;12° to the last architecture)			
31	Balāsāghūn	81;30	47;40
32	Bulghār	87;0	49;30
33	Lārsū	89;0	54;0
34	Alqura	80;0	48;20
35	Fawra	78;0	60;30

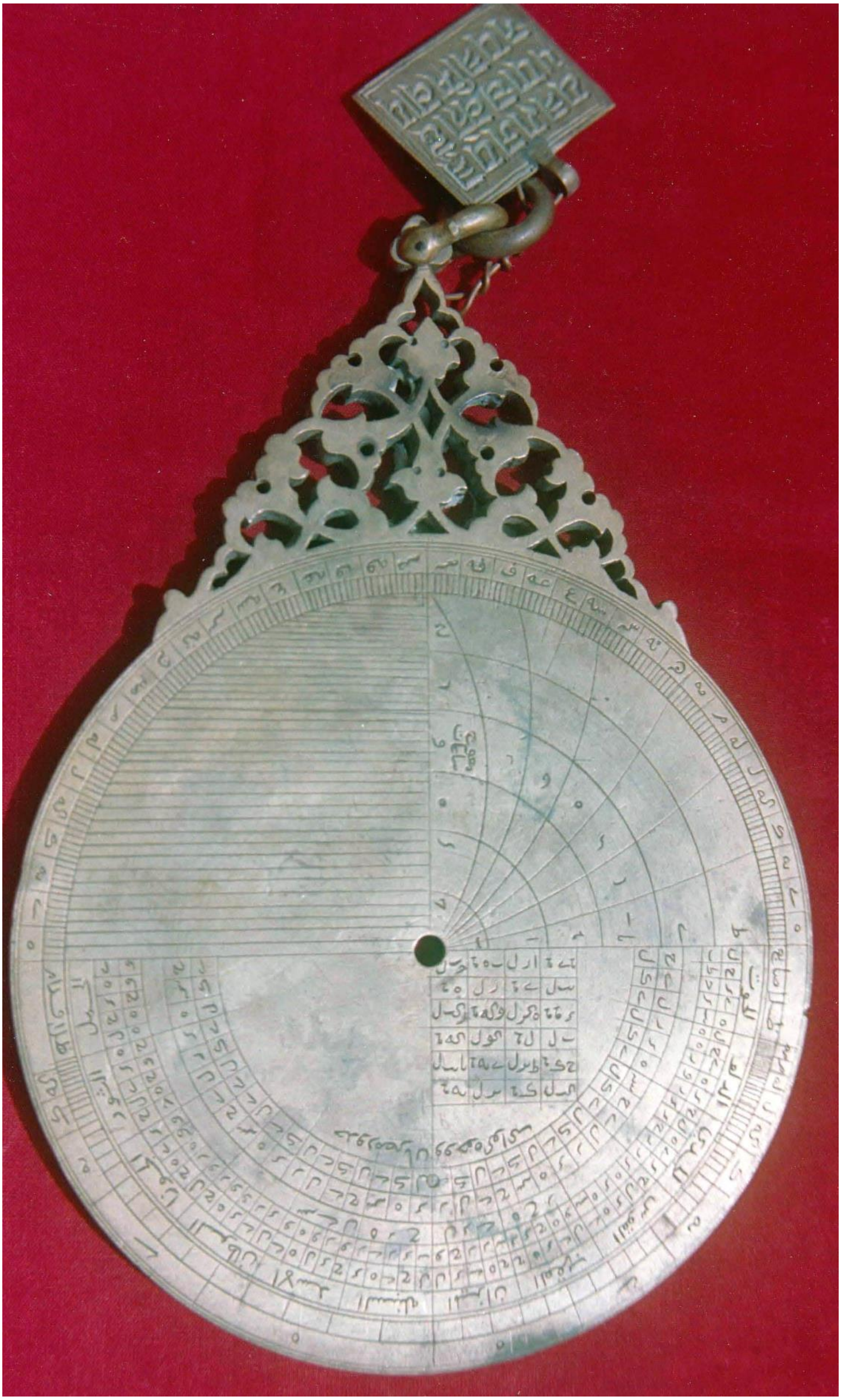
Figure A131.4 – Back of the astrolabe (photo by S. R. Sarma)

BACK

Altitude scales are engraved on the upper half of the rim; these are divided in 1° and 5° and numbered 5---90; 90---5. The trigonometric quadrant on the upper left is engraved with some 36 (!) horizontal parallels at gradually decreasing intervals.

The solar quadrant on the upper right is divided by five declination arcs into 6 zones, one for each pair of zodiac signs. The signs are marked with their serial numbers along the two radii. On this is drawn a universal horary quadrant with six lines of unequal hours, which are numbered serially as they proceed from the horizontal radius to the vertical radius. Near the vertical radius is a label *sāᶜāt muᶜawwaj* (unequal hours ?).

In the lower half there are no shadow squares, but there are co-tangents scales and their subdivisions on the rim. In the scale on the left, the unequal divisions are numbered clockwise from the meridian onwards as 0, 10, 15, 20, 25, followed by the label *ẓill aqdām.* On the right the divisions are numbered anti-clockwise as 0, 10, 15, 20, 25, 30, 35, 40, 45, followed by the label *ẓill aṣābiᶜ*.

These scales are followed by 6 semi-circular rows. Counting from the outside, rows 1-3 contain the table of limits, with the names of the signs in row 1, the names of the planets, except the sun and the moon, (expressed by the last consonants of their names) in row 2 and their individual strengths (indicated by *abjad* numerals) in row 3.

Table A131-4 Table of the Limits

Aries	Jupiter	6	Venus	6	Mercury	8	Mars	5	Saturn	5
Taurus	Venus	8	Mercury	6	Jupiter	8	Saturn	5	Mars	3
Gemini	Mercury	6	Jupiter	6	Venus	5	Mars	7	Saturn	6
Cancer	Mars	7	Venus	6	Mercury	6	Jupiter	7	Saturn	4
Leo	Jupiter	6	Venus	5	Saturn	6	Mercury	7	Mars	6
Virgo	Mercury	7	Venus	10	Jupiter	7	Mars	4	Saturn	2
Libra	Saturn	6	Mercury	8	Jupiter	7	Venus	7	Mars	2
Scorpio	Mars	7	Venus	4	Mercury	8	Jupiter	5	Saturn	6
Sagittarius	Jupiter	12	Venus	5	Mercury	4	Saturn	5	Mars	4
Capricorn	Mercury	7	Jupiter	7	Venus	8	Saturn	4	Mars	4
Aquarius	Mercury	7	Venus	6	Jupiter	7	Mars	5	Saturn	5
Pisces	Venus	12	Jupiter	4	Mercury	3	Mars	9	Saturn	2

Rows 5-6 contain the tables of faces with the names of the planets in row 5 and the numerical values of the faces in 6. Row 4 is only partially filled, with three names each for the four signs Leo, Virgo, Libra and Scorpio, as shown the last three columns in the table below; the significance of these additions eludes us.

Table A131-5 Table of the Decans and their Regents

Signs	10°	20°	30°		10°	20°	30°
Aries	Mars	Sun	Venus				
Taurus	Mercury	Moon	Saturn				
Gemini	Jupiter	Mars	Sun				
Cancer	Venus	Mercury	Moon				
Leo	Saturn	Jupiter	Mars		Sun	Jupiter	Saturn
Virgo	Sun	Venus	Mercury		Venus	Moon	Mars
Libra	Moon	Saturn	Jupiter		Saturn	Mercury	Jupiter
Scorpio	Mars	Sun	Venus		Venus	Mars	Moon
Sagittarius	Mercury	Moon	Saturn				
Capricorn	Jupiter	Mars	Sun				
Aquarius	Venus	Mercury	Moon				
Pisces	Saturn	Jupiter	Mars				

Under these rows are written the names of these tables: *ḥudūd miṣriyān wa wujūh kawākib* (the limits of the signs according to the Egyptians and the faces of the planets).

Finally, in the space between these semi-circular scales and the horizontal diameter, a rectangular table is engraved on the right with 4 columns and 6 rows. I am unable to explain this table.

ALIDADE

The alidade is a straight bar alidade with ornate ends and a plain centre-piece. The right arms bears, in the upper register, a sexagesimal scale to match the trigonometric quadrant on the back; the lower register is marked with seasonal hours for the occasion when the alidade is used as a sundial. The left arm of the alidade is marked with declination arcs and the serial numbers of the zodiac signs as in the solar quadrant on the back.

Figure A131.5 – The *kursī* and the plaque (photo by S. R. Sarma)

PROVENANCE

This astrolabe, along with other Lahore astrolabes, was acquired by Sawai Jai Singh of Jaipur in the first quarter of the eighteenth century and formed part of his personal collection, where a small copper plaque was added to it in Devanagari script and Rājasthānī dialect. The plaque reads:

ya[n]trarāja patra 5 pā[ṃ]c ko chai bhapatra sivāy

'Astrolabe plates 5 five [.] six along with the rete [.]'

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A132⊙ ASTROLABE ATTRIBUTABLE TO THE LAHORE WORKSHOP

Not dated, 17th century

Diameter 130 mm

London, Science Museum (#1953-264)

Figure A132.1 – Front of the astrolabe (photo courtesy Anthony J. Turner)

This astrolabe is slightly larger than the previous specimen and has a different type of *kursī;* otherwise the rete is exactly similar and the configuration on the back is almost the same. As in the previous astrolabe, here also the plates are held in position by a pin projecting out of the mater a little above the north point. Therefore, these two astrolabes must have been produced by the same maker.

COMPONENTS

Body with *kursī* (d. 130, h. 163, t. 6.5), ring and shackle, rete (d. 114), 4 plates, alidade, pin and horse.

FRONT

The ring is larger than the shackle, the shackle is trifoliate. The *kursī* is solid, with complex profiles and two large ornamental holes on each side; the finial does not appear to be trifoliate. The limb is divided in 1° and 5° and numbered in 5s clockwise from 5 to 90, separately in each quadrant.

RETE

The rete is exactly the same as in the previous astrolabe with the same star pointers.

PLATES

There are four plates, serving latitudes 18° and 37°; 22° and multiple horizons; 24° and 27°; 30° and 36°. The duration of the maximum daylight is not mentioned on the plates. Altitude circles are drawn for every 6° and azimuth arcs for every 10°. There are lines for seasonal hours and equal hours.

GEOGRAPHICAL GAZETTEER

As in A0131, here also the inner surface of the mater is filled only in the outer periphery, by the names and coordinates of 42 localities, and a large space in the middle is left empty.

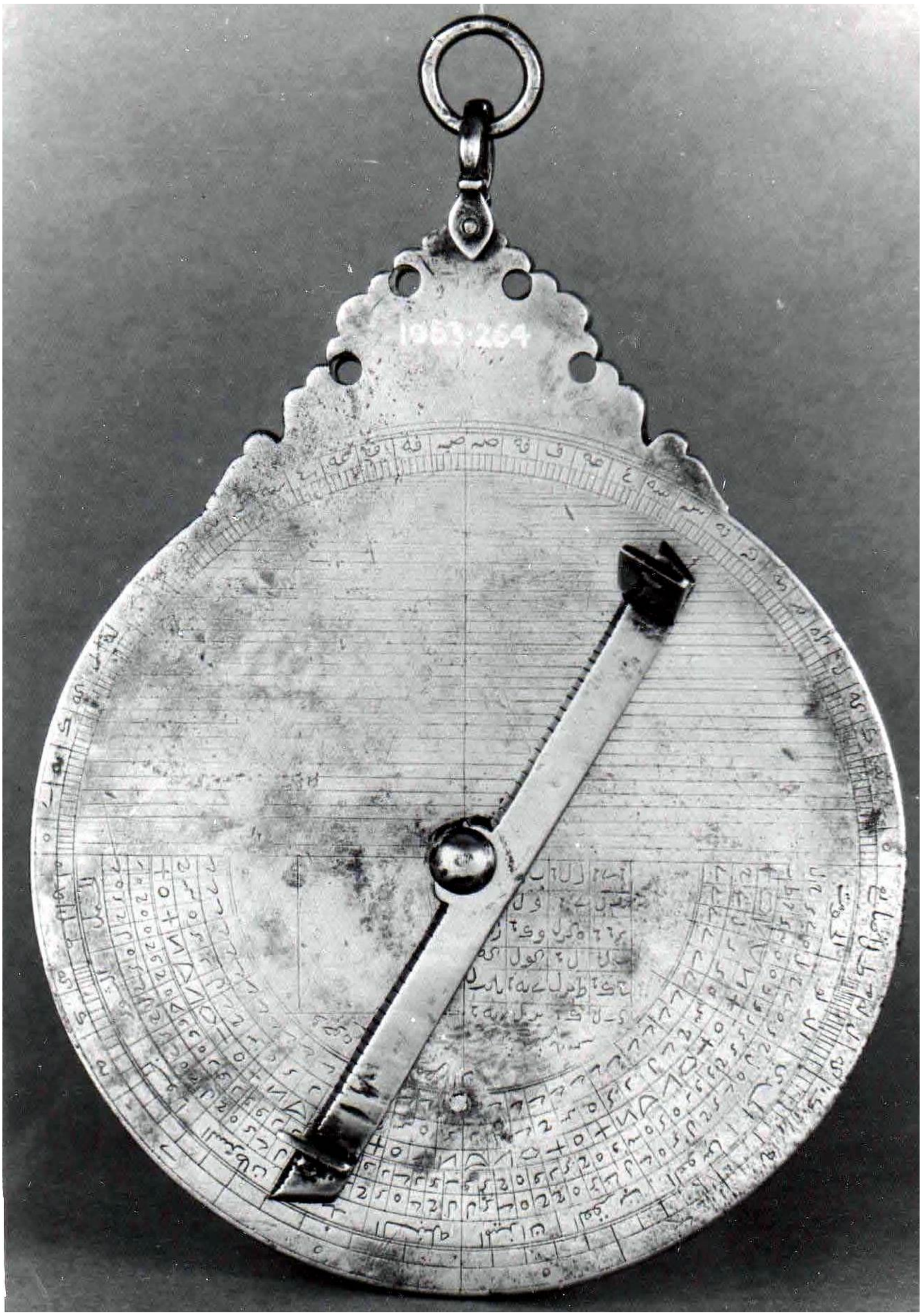
Figure A132.2 – Back of the astrolabe (photo courtesy Anthony J. Turner)

BACK

On the back, the upper half of the rim carries two altitude scales which are divided in 1° and 5° and numbered as 5—90; 90—5. In the previous astrolabe, in the upper left

quadrant, some 36 horizontal parallels are drawn with gradually decreasing intervals. These are drawn in both the upper quadrants in this astrolabe.

The lower half is almost the same as in A131. There are the cotangent scales, the table of limits in rows 1-3 and the table of faces in rows 5-6 as in A131. In row, however, the individual values of each face is given as 10 in each cell, instead of the cumulative values 10, 20, 30 as is the general practice. The label is slightly different: *wujūh wa ḥudūd miṣriyān* (the faces and the limits of the signs according to the Egyptians). There is also the unidentifiable table on the right-hand side. The main difference is row 4 which is filled with strange symbols as shown in Figure A132.3 below.

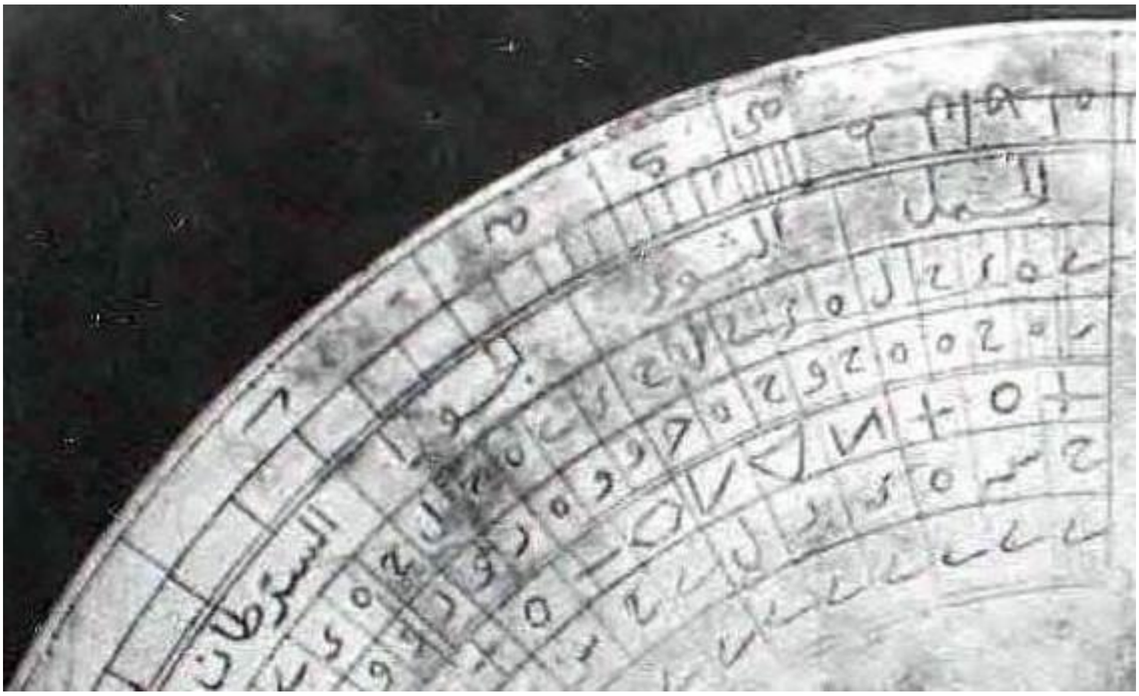

Figure A132.3 – Unusual symbols in the third row from below (detail of Figure A132.2

ALIDADE

The two ends and the centre-piece of the alidade are plain. The upper edge on both sides is graduated.

A133 ASTROLABE ATTRIBUTABLE TO THE LAHORE WORKSHOP[539]

Not dated, 17th century

Diameter 95 mm

PLU; ex-collection of Henri Michel

Figure A133.1 – Front view of the astrolabe
(photo courtesy of the Museum of the History of Science, Oxford)

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[539] Entry based on the photos in the archives of the Museum of the History of Science, Oxford.

This small astrolabe, dominated by the huge donkey's head adorning the wedge, should be well known to the readers of Henri Michel's *Traitè de l'Astrolabe* (plate XXIII). It was in his personal collection; its present location is not known. The *kursī* is reticulated and carries a trifoliate finial as in the Lahore astrolabes. The configuration on the back with three curves of the meridian altitude of the sun at latitudes 27°, 29° and 32° in the solar quadrant and the astrological table inside the shadow squares are reminiscent of the small astrolabes by Ḍiyā' al-Dīn Muḥammad. But unlike the Lahore astrolabes, the equator is represented on the rete in two segments. Since the solar meridian altitude curve at latitude 29° began to be added on the Lahore astrolabes after Shah Jahan shifted the Mughal capital from Agra to Delhi 1648, this astrolabe may have been manufactured after his date. No details are available save the photos of the front and back.

COMPONENTS

Body with *kursī* (d. 95), ring and shackle, rete, plates (?), alidade, pin and wedge.

FRONT

The shackle is trifoliate and the reticulated *kursī* bears a trifoliate finial. The limb is divided in 2° and 6° and numbered clockwise in 6s from 6 to 90, separately in each quadrant.

RETE

In the rete, the two rings of the Tropic of Capricorn and the ecliptic are held together by the equinoctial bar which has counter changes at its two intersections with the ecliptic ring. The ecliptic ring is divided in 12 signs of the zodiac; in each division the name of the sign is engraved. Each sign is divided in 6° and numbered from 6 to 30. Two large segments of the equatorial ring are represented, one inside the ecliptic ring and the other below it. Traces of the circles of equator and of the Tropic of Cancer are visible on the surface. About 28 named star pointers can be seen in the available photo. These are joined by an irregular tracery.

Plates

It is not known how many plates are in this astrolabe. In Fig. A133, the plate beneath the rete carries a double projection with altitude circles for every 6° and lines for seasonal hours, but no azimuth arcs.

Geographical Gazetteer

No information is available.

Back

The rim of the upper half carries two altitude scales which are divided in 2° and 6° and numbered in 6s as 6—90; 90—6. In the upper left quadrant are traced 30 horizontal lines. The upper right quadrant is divided by 5 declination arcs into 6 zones, each of which represents a pair of zodiac signs. Three sigmoid curves are drawn here to indicate the sun's midday altitude throughout the year at latitudes 27° (Agra), 29° (Delhi) and 32° (Lahore). The last curve is accompanied by the label *khaṭṭ niṣf al-nahār bi-ᶜarḍ 32* (the line of midday at latitude 32°); the others have shorter labels: *bi-ᶜarḍ 27* and *bi-ᶜarḍ 29.*

Two shadow squares are engraved in the lower half; on the left for a base of 12 and on the right for a base of 7. The vertical and horizontal scales on both sides are divided and numbered accordingly. They are accompanied by the following labels:

Vertical scale on the left:	*ẓill sullam aṣābiᶜ maᶜkūs* (scale of reverse shadows in digits)
Horizontal scale on the left:	*ẓill sullam aṣābiᶜ mustawī* (scale of direct shadows in digits)
Horizontal scale on the right:	*ẓill sullam aqdām mustawī* (scale of direct shadows in feet)
Vertical scale on the right:	*ẓill sullam aqdām maᶜkūs* (scale of reverse shadows in feet).

The lower half of the rim is engraved with two cotangent scales; the scale on the left is in feet; it is accompanied by the label *ẓill aṣābiᶜ* (shadows in digits) and that on the right by the label *ẓill aqdām* (shadows in feet).

Inside the shadow squares there are two semi-circular rows; while the outer one carries the serial numbers of the signs, the inner one carries the names of the 28 lunar mansions.

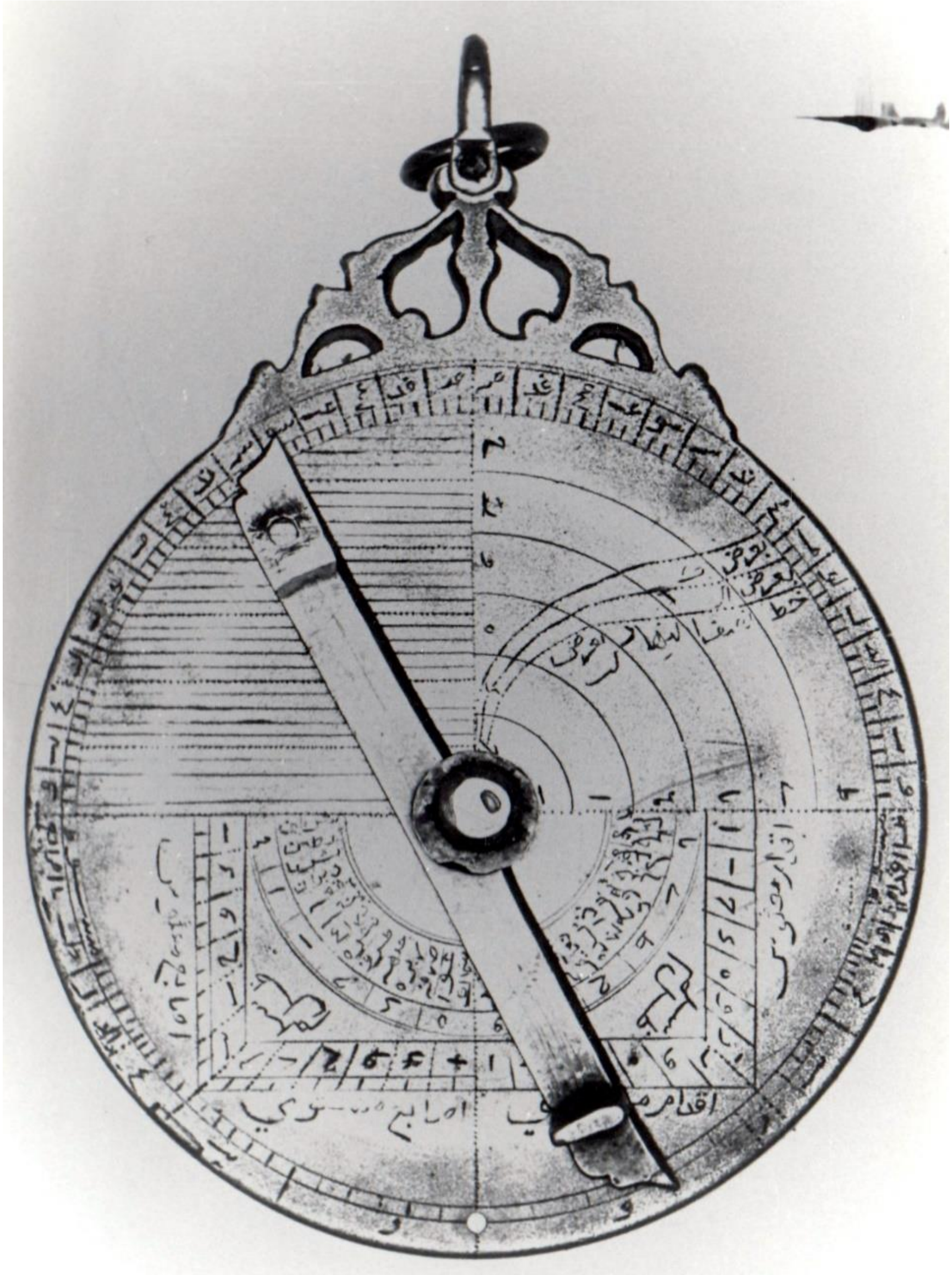

Figure A133.2 – Back view of the astrolabe
(photo courtesy of the Museum of the History of Science, Oxford)

ALIDADE

The alidade has ornate ends and an ornate centre-piece, but is not graduated.

APPENDICES

* To be released in a future version of the Catalogue.

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APX.B INDEX OF MUSEUMS WITH INDIAN ASTRONOMICAL INSTRUMENTS

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A039

New York, Brooklyn Museum
A064

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